APR 1 2 1946

The Journal of the *International College of Surgeons*

FRED H. ALBEE MEMORIAL ISSUE

John Royal Moore,
M.D., F.A.C.S., F.I.C.S.,
Guest Editor

Vol. IX *January-February, 1946* **No. 1**

To Surgeons
...IN PEACETIME
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Then, V-E Day was still to be won...V
away and the nation, on the war and h
geared for and fighting a world war.
The last 12 months have been truly momentou
of these military victories have been won and a
becoming history. But the war against disease and illn
must go on...and the surgeon who valiantly held the line
on the home front as well as he who succored and restored
the bodies of friend and foe alike in battle...both have met
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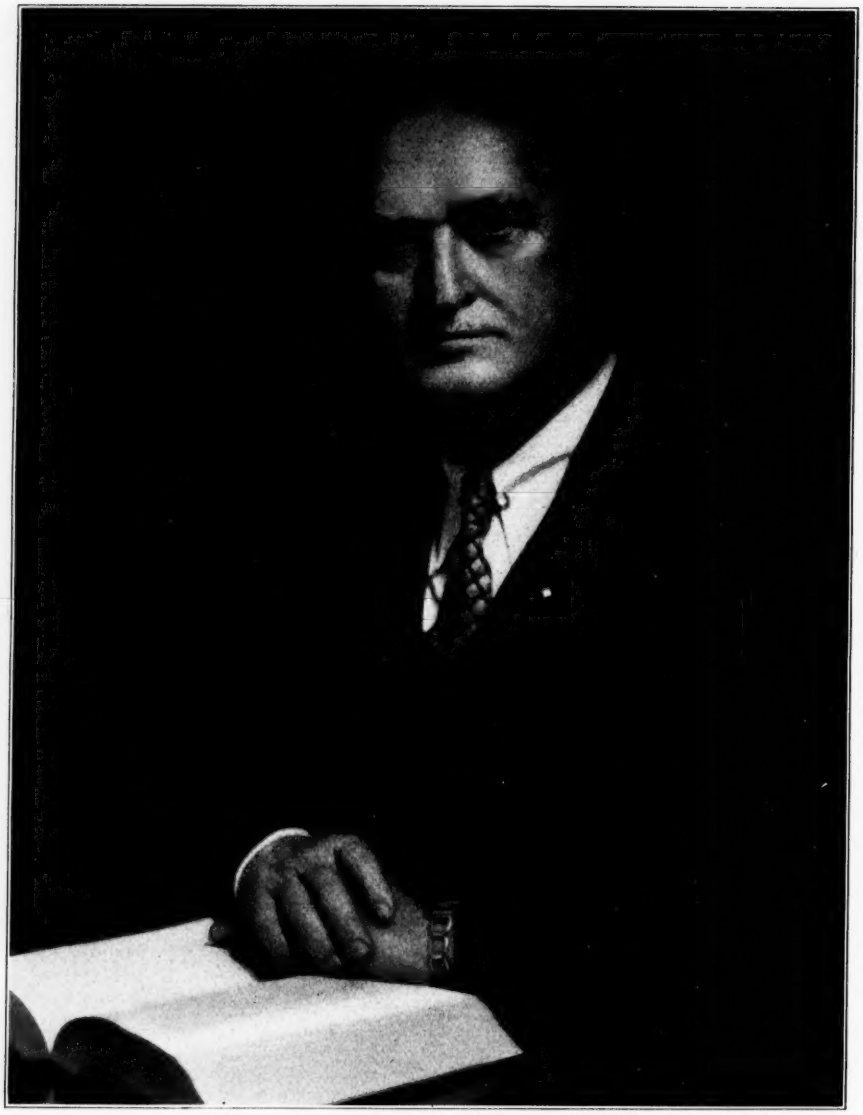
In Memoriam

Fred Houdlett Albee, M.D.

1876 - 1945



Courtesy of The Journal of Bone and Joint Surgery

FRED HOUDLETT ALBEE, M.D.

Editorials

Fred H. Albee, M.D., F.A.C.S., F.I.C.S.

FRED H. ALBEE was born in Alna, Maine, on Friday, February 13, 1876. The International College of Surgeons came into being many years later, in 1935. Yet they were much alike in this, that both were pioneers.

Dr. Albee's fame in the scientific world derives primarily from his pioneer work in bone graft surgery; the College was the gathering place for a whole group of surgical pioneers. Each in his own way and to his own field, contributed much to the advancement of surgery as we know it today. In actual time, the period covered is relatively brief, no more than the span of a single life. In increase in scientific knowledge, it is an eon.

Dr. Albee, perhaps even more than any other of this pioneer group with which he was associated, showed, possibly his greatest virtue in his internationalism. He recognized that human misery—and with it, the cry for rehabilitation—knows no boundaries, physical or spiritual. "La Science n'a pas de Patrie." And he acted strictly as he saw.

His early training, oddly enough, was in tree grafting; "I saw sweet apples growing on a sour apple tree."[1] His vision, grasping at that which eluded less perceptive minds, saw the analogy to human bones. This experience was the basis for his experimental work in bone graft surgery in its human adaptation.

To see and to do is one thing. To write, to teach, to pass on one's knowledge and experience to those who come after, can be quite another. Only those not simply blessed with special gifts, but endowed by nature with inexhaustible energy and the trait of strictest adherence to fundamental principles, can *do*, and *teach* as well. Fred Albee possessed these attributes to a surpassing degree. His statement of the requirements for a successful bone graft are classic, and become a part of history:

"The basic law of bone graft is that, to be successful, a bone graft must be so selected and so fitted in the host bone (the bone in which it is implanted) that blood circulation through the two bony parts will be effected and maintained.

"The second law is that bones should be grafted only from the same species."

In addition to his work in the practical field—living monuments to his memory, are those who walk and work and go through life normal and erect because of his skill—he wrote texts which have become standards for his specialties: "Orthopedics and Reconstructive Surgery," "Hip Joint Surgery" and—published posthumously in conjunction with Powers and McDowell—"Surgery of the Spinal Column." These, like his patients, are fitting tributes to his ceaseless efforts and unwavering steadfastness of purpose.

[1] "A Surgeon's Fight to Rebuild Men," Dr. F. H. Albee.

Dr. Albee deserved—and enjoyed—public acclaim. The brilliant reclamations of massive bone defects accomplished on casualties in World War II, may justly be attributed—directly or indirectly—to the fundamental principles he so well established. Yet no one would have been quicker than he to remind those who offered him personal acclamation.

"Remember that the life and the health of your patients depend upon your knowledge and moral sense. Never let material and personal advantages become your guide. Remember that it is your duty to work unceasingly toward professional perfection. Never forget the respect you owe your fellow members"[2] (of the College).

A few lines of poetry come to mind as a nearly-perfect summation of all Fred Albee was and stood for and believed,

"Do what thy manhood bids thee do, from none but self expect applause;
"He noblest lives and noblest dies who makes and keeps his self-made laws."[3]

JOHN ROYAL MOORE

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[2] Translated from the French.
[3] "The Kasîdah of Hâjî Abdû El-Yezdî" by Sir Richard F. Burton.

Fred H. Albee—The Colleague

THOSE of us who were fortunate enough to have known and collaborated with Fred H. Albee during the many years of his brilliant career and accomplishments can think of him, in his manifold traits and gifts of mind and skill, as the miracle man and the architect of the human skeleton.

The colleague among us, Fred H. Albee stood as a tower of strength, in silent assurance of his loyalty to his professional associates. Fred never left us in doubt as to his judgment and convictions. With characteristic frankness, one always knew where Fred stood on any question or issue. His wholesome candor and fearless personality impressed all of us, his colleagues, with his Spartan qualities and the courageous expression of his concepts and opinions. At the bedside, in the research laboratory, in the operating room, his inquiring mind and originality demonstrated to us the earnest simplicity of his method, the strength of his beliefs and the honesty of his conclusions.

It was the privilege of my family, on one occasion, to be the guests of Fred Albee and his household in their home at Colonna, New Jersey. There the intense scientist, the skilled surgeon, relaxed in the role of host. His charming hospitality has left unforgettable memories and admiration of a personality, at once the genius in his profession and the home maker to his kindred.

The same skill and inventive mind which distinguished his career were displayed in the landscaping of his home

(Continued on page 6)

Fred Albee—The Man

IN beauty and strength the fir tree increases year by year. Between the sturdy fir and the memory of the late Fred H. Albee there exists an analogy so close as to be almost coincidental. Qualities of Dr. Albee as a *man* were the traditional constituents of nobility of character and of distinction of self based upon the eternal verities of human endeavor and aspiration. Such inherencies beget both enduring and exquisite recollections! Their fragrance stimulates the weary heart.

As a man and scientist, the flesh and blood and bone of Fred Albee are now but a memory. Yet as an intelligence, as a spirit and as a scientific Messiah and a loyal, loving friend, Fred Albee still walks the earth with vigor, hand in hand with those who loved him in life and who commune with him in death.

For Fred Albee was above all else a "man among men". Inherently a great positivist, he brooked small interference with either his ideas, his prejudices or his expression of his principles or convictions. This mental positivity, coupled with a definite austerity of personal traits made for Albee both friends and enemies. Undoubtedly he was opinionated and most adamantine where those opinions were concerned. He was a splitter of hairs and a constant seeker for the verities. Convinced that he was right in his viewpoint and that the polarities of his convictions guided him toward the way of *Truth,* his stand was immovable. Ultimately any man of such fibre commands both the love of his friends and the respect—even though reluctant—of his critics and his disputants. Such is the fate of every dynamic character.

A fundamental cause for Fred Albee's love *for* the people, was that he was *of* the people. His mouth at birth curled around no golden spoon—rather, a questionable utensil of pewter was between his infant lips. From his very beginnings, Fred Albee had to keep his mind on the stars and his feet on that shaky, slippery ladder that leads to recognition in a profession and to success in the eyes of the laity.

Albee's idea was to be a mender of men. He became that in the superlative sense. Following the biblical admonition, "Suffer ye the little children to come unto me," Albee began his mending with the infants in their cradles. On the 'scutcheon of surgery's immortals this work of Albee is conspicuously engraved. So long as orthopedic surgery serves as an aide-de-camp to humanity, just so long will Fred Albee be remembered for his accomplishments and innovations. And for an equally long time will survive his contributions to the welfare of mankind!

Dr. Fred, physically speaking, was a *rugged* man. His florid face, and his beaming countenance radiated good fellowship and the man's love for mankind. His laugh was contagious; his heart and morals as clean as the proverbial whistle, and his substantial stature exuded the stability of the Rocks of Time.

My first intimate contact with Albee was at a sectional meeting of the International College of Surgeons at Tampa, Florida. We were sitting side by side, and, as the coffee was served, he leaned over to me and remarked,

"You know, I want to join this organization both because of its warmth and its obviously *democratic spirit.*"

And so, Fred Albee became a Fellow of the organization. Only a little later,

he was a National regent in orthopedics, and before long, the President.

An indefatigable person, he spent much of his time in the interest of the college. His devotion to its precepts is unforgettable. When the College met in Venice, Fred walked on crutches, but his face was wreathed in smiles, and his enthusiasm was unbounded for the purposed program. He radiated laughter and energy. In this he was spurred by his devoted wife, to whose patient and continuous encouragement is due much of his successful achievement.

Albee realized, too, the necessity for *personal appearances* at society meetings. He never missed one of the College's Assemblies, whether national or international. Fanning his fellow professionals to vigorous action and to the joys of accomplishment, ever in the lead was the dominant figure of Fred Albee. Even when the shadows of his mundane existence were lengthening, at his own expense and at the ill-justified loss of his own time, he took the good-will tour to South America, *in the interest of the College, and not in the interest of Fred Albee or any other individual!* This he did at the peril of his health, but for love for the *College!* Small wonder the College reciprocated this affection and reveres the memory of Fred Albee.

Convinced of the justice of a cause, by those convictions Fred Albee rose or fell. Within his scope of action, friendships might know no rupture, nor confidence any betrayal, nor might there be any "pussy-footing", nor "double talk", of so-called diplomacy, nor bearing of malice, nor exercise of subterfuge. Fred Albee abstained, more than from anything else, from the "carrying of water on both shoulders".

In a long life under varied conditions I have met few, if any normal, honest humans who fail to relish admiration from their peers over successful effort. Yet about the worst thing his few critics have said against Albee was that he appreciated to a great degree and even expected tributes of admiration and esteem. Such chatter and talk always reminds me of the man who once questioned the late Elbert Hubbard in this respect:

"Tell me, Mr. Hubbard," said he. "What must I do to avoid unjust criticism? What am I to do to avoid being talked about?"

To which the Sage of Aurora replied, "The infallible formula for that is, if you do not want people to talk about you, say nothing, *do nothing, Amount to Nothing!*"

Of course Fred Albee was always saying something, doing something and amounting to something. His rewards were distinction, peans, honors and—*criticism!* His precepts and his teachings were of sterling worth. In the orbit of truth, they will live on and on.

His services were at the beck and call of prince and pauper both, without distinction. Once I watched him negotiate a delicate operation on a penniless boy. The postoperative radiogram revealed an excellent apposition of the structures involved and he was showered with congratulations. Later, at luncheon, Fred sat deep in thought. Excusing himself abruptly, he 'phoned his surgical staff to meet him immediately in the operating room and to bring back the patient for a readjustment. With promptitude, the readjustment was performed and scrutinized punctilliously. Another set of X-rays was taken. When these came, Albee beamed all over.

"Now, *that's* the way I want it."

"It was all right the first time, doctor," some one ventured.

"*All right,* yes," he retorted. "After the first operation, I grant you, the result was good. But I wanted it to be *perfect.* NOW it *is* perfection and it is for perfection that all of us should aim."

To those stout hearts who live and love, and who appreciate devotion, affection and impeccable probity, the memory of Fred Albee is a delight, a blessing and a comfort. Because of him, both the surgeons' world and that of those whom the surgeons serve, is a better place in which to live.

MAX THOREK

Fred H. Albee—An Appreciation

MY first meeting with Fred Albee was immediately after the death of our mutual friend, Harlow Brooks. I reminded Dr. Albee that Dr. Brooks had told me I could depend on Dr. Albee to come to the Clinical Conference to be held the following fall at Sage Memorial Hospital out in the middle of the Navajo Reservation. His reply was simple and characteristic, "If I told Harlow Brooks I would go, I will certainly be there."

In those few straightforward words, did the man who had fathered bone-graft surgery and made some of the most startling discoveries and contributions to orthopedic surgery commit himself to leave his busy hospital and office, to make the arduous trip to Arizona and to talk intimately with the small but select group of physicians and surgeons gathered at Ganado. Not only did he lecture formally and informally, but he performed miracles of reconstruction in the diseased bodies of many a Navajo Indian. Sometimes he would keep working far into the night.

His skill was uncanny. As one watched him literally take a hip to pieces or disarticulate a knee one wondered whether the parts would ever again have any semblance of order, then suddenly one saw the bones firmly and neatly mortised together by a craftsman's hand. Almost before one realized it, the long tibial graft was firmly wedged between the pelvis and the trochanter and the wound was rapidly being closed.

Dr. Albee was resourceful. On one occasion he needed an instrument we did not have. With scarcely a minute's hesitation, he went to the blacksmith shop and made the instrument himself!

The minute this master mechanic of the human frame took a knife in his hand, he was in another world. He demanded and received instant and complete cooperation from those assisting him. His sternness and frequent severity and impatience with even the slightest delay in the operating room, often gave casual acquaintances the impression that this great man had no sense of humor. Nothing could be

further from the truth. No one enjoyed a good story or a practical joke more than Fred Albee.

At one of our Ganado Clinics, Dr. Albee and Dr. J. M. Greer of Phoenix had been operating until late at night. We retired about midnight; shortly afterward Dr. Greer came to our bedroom door and said, "Something terrible has happened. Dr. Albee has lost $350. He left it in his suit when he went to the operating room and now it's gone." We went to the hospital, searched every nook and corner of my office where he had changed his clothes, searched every suit and piece of linen that had been sent down the chute from the operating room. Then we came back to the house and searched every suit and suitcase, but all to no avail. Expecting to continue the search in the morning we had finally turned in again, when Dr. Greer came again and rapped on our door. "The money was found. Dr. Albee had put it in his shoe before he went to surgery." Dr. Albee took the inevitable good natured "ribbing" that followed in the best of spirits.

Albee was a man in whom there was no place for the cheap varnish that so often gilds a lesser soul. There was never any doubt where Fred Albee stood on any subject. There was a glowing enthusiasm and justifiable pride in the procedures and instruments he had perfected because he knew they were right.

Orthopedic surgery has lost one of its greatest original thinkers and finest technicians. His friends have lost a whole-souled, loyal and devoted comrade.

For many years to come, there will be walking living monuments to his courage and skill on this great Navajo Indian Reservation; and not only here but in every state in the Union and in every civilized country of the world, there are thousands who will call him blessed.

CLARENCE G. SALSBURY

(Continued from page 2)

at Colonna, where he converted the flat land of their property into mounds, knolls and hillocks, with rock gardens, running streams and shady, cozy corners of varying interest and beauty.

Fred Albee's personality and genius were in him so happily combined that "nature might rise up and say to all the world, this was a man."

DÉSIDERIO ROMÁN, President,
International College of Surgeons

Original Articles

Pseudoarthrosis of the Tibia and Fibula in Children

JOHN ROYAL MOORE, M.D., F.A.C.S., F.I.C.S.
PHILADELPHIA, PENNSYLVANIA

FRED H. ALBEE, to whom this Memorial Issue of the "Journal of the International College of Surgeons" is dedicated, belongs to a group of pioneers in the field of surgical internationalism. Together, these men represent every field of surgical endeavor. Dr. Albee himself, as is well known, derived his fame primarily from his work in bone graft surgery. As early as 1911, he outlined certain requirements for a successful bone graft, which are worth repeating. They are: (1) the autogenous graft; (2) cortical bone; (3) preservation of the periosteum; (4) fitting of the graft in layers, i.e., periosteum to periosteum, cortical bone to cortical bone; (5) the "glass stopper" fit, i.e., a mechanically perfect fit; (6) the graft to be self sustaining; (7) the graft bed to have adequate blood supply; and (8) adequate external splinting. These have withstood the test of time and form the basis of the technic of bone grafting. even today.

One of the most difficult problems in bone graft surgery is pseudoarthrosis in children. Herewith I present a method employed in the treatment of twelve cases of pseudoarthrosis in children at Shriners' Hospital for Crippled Children in Philadelphia, Pennsylvania. This method is based on the principles outlined by Dr. Albee.

Chief Surgeon, Shriners' Hospital for Crippled Children, Philadelphia; Chief Orthopedic Surgeon, Temple University Hospital; Professor of Orthopedics, Temple University Medical School.

Briefly, the method is as follows: An osteoperiosteal graft, approximately the full length and width of the good tibia, is cut with the twin saw, lifted from its bed and replaced immediately. Careful closure of the subcutaneous tissue and skin is followed by pressure dressing and immobilization of the extremity in plaster of paris from tip of toes to groin. While the patient is still under the anesthetic, unfavorable skin scars (due to previous operations or old sinuses), if present, are excised. At the end of three weeks, the pseudoarthrosis is exposed, all intervening scar tissue is excised and bone ends freshened and

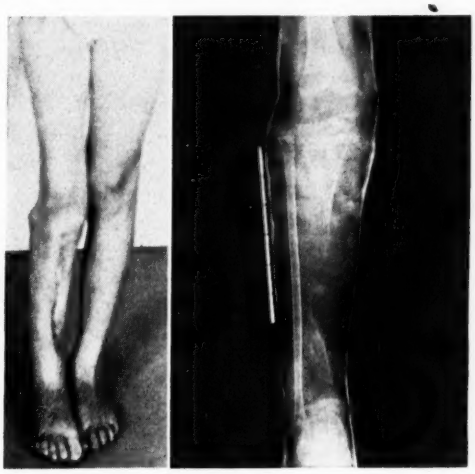

Fig. 1.—*Case 1* (left above) Anterior-posterior view of right leg showing short tibia, large scar defect, bowed leg, high fibula. Fig. 2.—(right above) Same patient; Aug. 12, 1942—roentgenogram of right leg, showing large defect in tibia.

split, clothespin style. The bone graft previously cut in the good tibia is then exposed and elevated from its bed along with the adherent osteoid tissue; the ends are beveled and wedged into the split ends of the pseudoarthrosis fragments. Wire sutures or kangaroo tendon are used to maintain internal fixation. The pseudoarthrosis fragments are then penetrated well away from the bone graft site by two Kirschner wires or Steinman pins per fragment (transfixation pins). A cast is then applied from tip of toes to groin, and the projecting pins or wires are incorporated into the plaster.

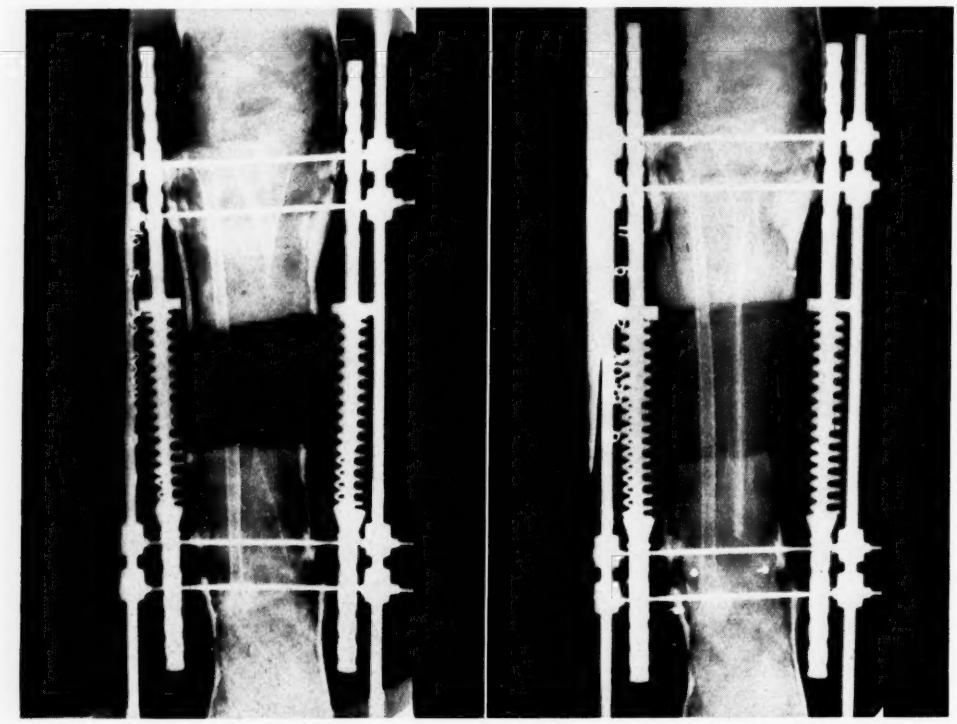

Fig. 3.—Same case as preceding (left above) Oct. 5, roentgenogram of right leg with lengthening apparatus in place; 2 inch (5 cm.) lengthening accomplished. Fig. 4.—(right above) Same patient; Nov. 6, bone graft in place.

The usual holding time in plaster averages twelve to sixteen weeks. Following removal of the plaster, a brace from ankle to groin, having peroneal ring, free knee, free ankle and long tibial lacer, is applied, together with elevation on the opposite shoe, and crutches. Weight-bearing is permitted at the end of the fifth month.

The same procedure has been employed in adults. The routine is identical, with the exception of the fact that the bone graft is kept in its normal bed, four weeks instead of three, in order to get what is believed to be an equivalent amount of osteoid tissue.

On the group of twelve patients cited, eight had congenital pseudoarthrosis and four were examples of a condition secondary to partial diaphysectomy

employed in the treatment of osteomyelitis of the tibia. The end results in the twelve cases were as follows:

Congenital pseudoarthrosis; end result—one failure, one refracture, six solid unions; follow-up, four years.

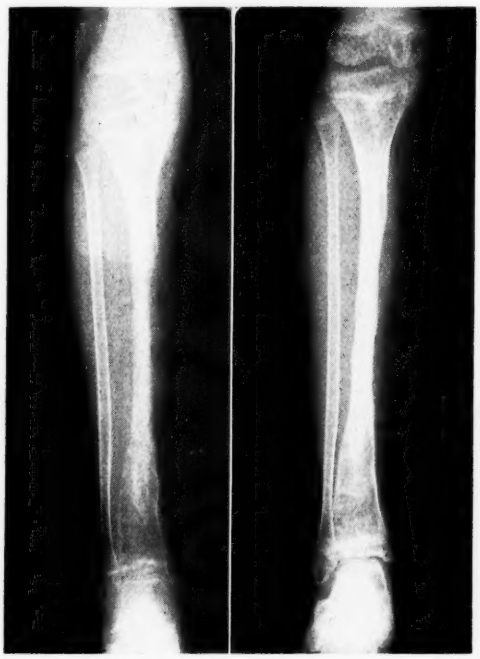

Fig. 5.—Same case as preceding (left above) roentgenogram, Feb. 1, anterior-posterior view. Fig. 6.—Same patient; roentgenogram, Feb. 24, 1944, showing development of tibia approximately 18 months after bone graft.

Pseudoarthrosis secondary to osteomyelitis of the tibia; end result—solid bony union; follow-up, four years.

Svante Orell, in 1937, described three forms of grafts, which he termed "os purum," "os novum," and "boiled bone." Os purum is bone which has been freed from fat, connective tissue and proteins, by means of a lengthy physiochemical process but which is not freed entirely of all the collagenous matrix. The protein is extracted by soaking the bone in salt solution; connective tissue on the bone surface and in the haversian canals is removed by warm potassium hydroxide; fat is extracted by soaking in acetone. Os novum, in contradistinction to os purum which is composed of the calcium framework of dead bone, is immature living bone tissue with great proliferative power. It is produced by implanting a long narrow os purum splint of suitable shape beneath the periosteum of the tibia. It is excised two months later. Boiled fresh bone differs from os purum in that it contains fat, connective tissue and proteins.

The graft herein described belongs to the os novum group. It is surrounded by osteoid tissue, is partially decalcified, appears porous, is decidedly softer than normal bone and can be bent slightly without breaking. It appears partially

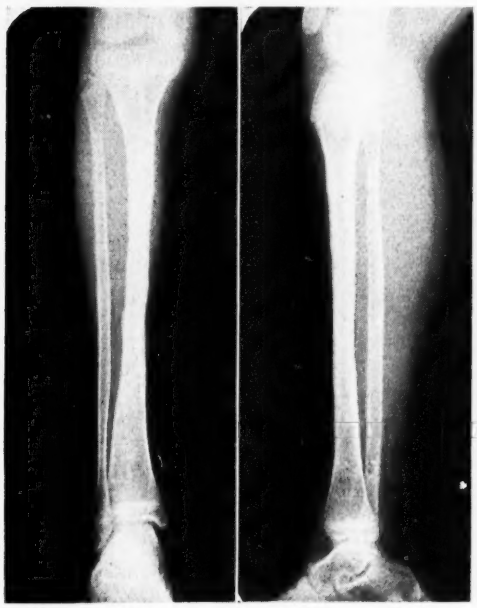

Fig. 7.—Same patient as preceding; roentgenograms of reformed tibia approximately 3 years after surgery. Note reconstruction of medullary canal; also practically normal contour of tibia.

Fig. 8.—*Case 2.* Feb. 6, 1941; anterior-posterior and lateral views of left leg, showing conbenital pseudoarthrosis. Note deformity of tibia, café-au-lait spots, etc.

Fig. 9.—Anterior-posterior and lateral roentgenograms showing congenital pseudoarthrosis of tibia and fibula. (Same patient, same date as fig. 8.)

decalcified in the roentgenogram and seems to calcify and blend with the fracture ends more rapidly than immediate graft transplants. The group of cases cited is, however, too small to draw any final conclusions.

The following two cases are presented as illustrative of the delayed bone graft technic employed in the group of pseudoarthroses previously referred to.

CASE 1.—M. J. J., aged 8, was admitted Aug. 10, 1942. In August, 1939, osteomyelitis had been treated by partial diaphysectom, resulting in a 3 inch (7.5 cm.) defect of the right tibia with pseudoarthrosis (fig. 1).

On Aug. 24, 1942, the scar on the right tibia was resected. As the scar was too extensive to risk a twenty-one day healing period, the delayed graft was not started. On September 25, leg-lengthening apparatus was inserted in the right tibia. On October 10, the first stage of the tibial bone graft operation was performed, with the second stage, transfer of the graft to the right tibia, being carried out on November 4 (figs. 2 through 8).

CASE 2.—R. G., aged 11, was admitted May 19, 1941. This patient had a congenital pseudoarthrosis of the left tibia together with von Recklinghausen's disease. Numerous operations had already been performed for repair. There were several adherent operative scars over the deformity.

On June 8, these scars were excised, together with the scar between the ends of the tibia, and lengthening apparatus was applied. The following January 26, the first stage of the tibial graft preparation was performed. The graft was transferred on February 25, the transfer having been delayed because of a small stitch abscess in the graft incision (figs. 9 through 14B).

COMMENT

The delayed graft is extremely difficult to evaluate. It is highly probable that an immediate graft would have taken equally well. In the second case

presented, as well as in several other cases of congenital pseudoarthrosis, several different types of grafts had been employed, including double onlay, chip grafts, inlay and onlay grafts and intermedulary grafts. These failed for reasons unknown, possibly faulty immobilization, perhaps infection, or the presence of a neurofibroma (von Recklinghausen's disease) (William Greene). As has been emphasized by many writers, the age of the patient seems to be a factor in the treatment of congenital pseudoarthrosis. This may have been a deciding factor in the cases cited.

Fig. 10.—Same patient as preceding; roentgenogram, showing tibia graft in place, two days after transfer.

Fig. 11.—Same patient as preceding; May 20, 1943, anterior-posterior roentgenogram, showing tibia and fibula approximately 14 months after transfer.

The idea of the delayed graft occurred to me as a result of the delayed osteotomy (paper to be published). In 1931, corrections of malformations of the long bones in both adults and children, were accomplished by an incomplete osteotomy followed by an osteoclasis, during the fourth and third weeks respectively. The osteoid tissue which developed in the bone defect at the site of the incomplete osteotomy, not only seemed to prevent displacement at the time of the osteoclasis, but also seemed to contribute to early solid bony union at the osteotomaclasis site.

In approximately three hundred cases, osteoclasis has been performed in the midshaft, and in the upper and the lower end of the long bones, for various deformities, including flexion deformity of the hip, malunited fractures, knock

knees and bow legs, and amputation. (Orr-Jones, Naval Hospital, Philadelphia.) In view of the previous work of Orell and the work on tissue culture by Dobrowolskaja and others, the employment of osteoid tissue along with mature bone might afford better graft material.

Fig. 12.—Same patient as preceding; Sept. 20, 1944. Roentgenogram showing anterior-posterior view of tibia, two and one half years after transfer.

Fig. 13.—Same patient as preceding; Aug. 20, 1945. Left leg, three and one half years after delayed bone graft. Medullary canal restored; alignment excellent.

Further experimental work should be done to prove this point, particularly in view of the modern biochemical conception of bone formation.

SUMMARY

The delayed bone graft is offered as a method in the treatment of pseudoarthrosis. Results in 12 cases are reported, two being illustrated by photographs and roentgenograms. In both of the illustrated cases, lengthening of the leg was procured of approximately 2 inches, thus adding to the hazard of bone graft. A four-year follow-up is shown in each case. The effectiveness of this type of graft is well demonstrated. The principles employed are essentially those outlined by the late Dr. Fred H. Albee; results may be regarded as a tribute to his pioneer work in bone graft surgery.

NOTE: Figs. 12 and 13 were inadvertently reversed in the printing. They represent the same leg as in the other figures of the same case.

RÉSUMÉ

Le graffage osseux est offert comme méthode de traitement des pseudoarthroses. Les résultats obtenus dans

douze cas sont rapportés; dans doux cas l'auteur montre les photographies et les roentgénogrammes. Dans ces deux cas, il y ent un allongement de la jambe de deux pounces cela ajoute aux hasards de la greffé osseuse. L'efficacité de la méthode de greffage est démontrée. Les principes employées sont essentiellement ceux qui furent tracés par le docteur Fred H. Albee; les résultats obtenus sont un éloge mérité à l'adresse de ce pionnier de la chirurgie de la greffe des os.

RESUMEN

Como un método en el tratamiento de la pseudoartrosis, el autor ofrece el injerto óseo retardado y da cuanta de 12 casos, dos de los cuales van ilustrados con fotografías y exámenes radiológicos. En los dos casos ilustrados, se procuró un alargamiento de la pierna de aproximadamente dos pulgadas, factor añadido a las posibilidades del injerto óseo. En cada caso se contunió el estudio por un período de cuatro años. Ha quedado bien demostrada la eficacia de ésta técnica. Los principios en ella empleados son, en esencia, los discritos por Albee. Los resultados satisfactorios obtenidos se deben, en realidad, a los trabajos de éste precursor de los injertos óseos en cirugía, por desgracia fallecido.

Свод

Поздний костный трансплантат предложен, как способ лечения ложного сустава. Доложены результаты в 12 случаях, из которых 2 иллюстрированы фотографиями и рентгенограмами. В обоих случаях было достигнуто удлинение ноги приблизительно на 5 см., увеличивая этим риск трансплантата. Даны четырехлетние наблюдения обоих случаев. Хорошо демонстрирована эффективность этого типа трансплантата. Эта операция основана на принципах, выраженных доктором Fred H. Albee. Результаты могут считаться достойной данью его пионерной работе по хирургии костной трансплантации.

Klumpke's Paralysis

(This is) "the result of an injury of the first dorsal nerve. It may follow a dislocation of the shoulder-joint or a violent upward pull of the arm, such as might be received by grabbing at a ledge while falling from a height. There is paralysis of all the intrinsic muscles of the hand, and a true claw-hand results eventually. It is necessary to look for paralysis of the cervical sympathetic, which is fairly often implicated in this lesion. If the cervical sympathetic is involved, it indicates that the lesion of the first dorsal nerve is near its exit from the intervertebral foramen, and therefore in an inaccessible position."

(From Hamilton Bailey's "*Physical Signs in Clinical Surgery,*" published by John Wright & Sons, Ltd., Bristol, England, 1944.)

Fusion of the Spine After Removal of Ruptured Disk

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MUCH of the confusion which has arisen as a result of the controversy with regard to the question of "to fuse or not to fuse" the spine at the time of excision of a ruptured intervertebral disk may be attributed to a lack, on the part of many physicians, of appreciation of the importance of the intervertebral disk in the physiologic function of the human spine.

The intervertebral disk is a most important entity in the structure of the human spine. This disk must support direct body weight and is also charged with the function of reducing shocks and jolts which occur in the normal routine of every day activity as they are directed from below upward through the spine toward the calvarium.[1, 2] In addition, the nucleus pulposus, occupying as it does a position just posterior to the center of the disk, serves as a hydrodynamic ballbearing and axis of motion. If the disk structure is lost as a result of a crushing injury, repeated minimal traumata, or surgical removal, the axis of motion and attendant stress is shifted backward to the small and relatively inadequate articular facets. The contiguous vertebral bodies may contact each other following loss of disk substance. Movements of the spine may then cause hypertrophic arthritic changes on the anterior margins of the vertebral bodies and in the articular facets.

The intervertebral disk is composed of three separate parts; the annulus fibrosus, the nucleus pulposus and the cartilage plates. The tough fibrous envelope, called annulus fibrosus, surrounds on all sides a soft and pulpy center, the nucleus pulposus. The fibers of the annulus are vertical in direction and each fiber is firmly attached above and below to the adjacent vertebral bodies. The annulus is thicker and much stronger anteriorly and laterally than it is posteriorly. In all forward bending the strain of weight and of muscle pull tends to squeeze this nucleus pulposus back toward the spinal canal where the strength of the annulus is least well preserved. Acute strains of this type or repeated minimal strains of hard physical labor may result in either stretching or tearing these posterior annulus fibers sufficiently to permit the nucleus pulposus material to bulge or to be actually extruded into the extradural portion of the spinal canal.[3] Strong cortical bone, covered on the disk side by a layer of hyaline cartilage, the cartilage plate, confines the nucleus superiorly and inferiorly. Only a fracture into the vertebral body will permit its escape in those directions.

Following earlier reports of the relief of sciatic pain by removal of herniated or extruded portions of the intervertebral disk, the neurosurgeons became interested in this pathological entity. Most of the earlier operations were performed by men who were primarily trained in the treatment of lesions of the nervous system. It was natural that they should have thought first and foremost, if not entirely, of the problem of relieving pressure on a nerve root, and secondarily, if at all, of the question of attempting in some way to preserve the structural support of the spine itself.

Most of the patients subjected to the simple excision of a herniated portion of a disk or the complete removal of a disintegrated disk, were immediately

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relieved of their sciatic pain. However, as the years have gone by, orthopedic surgeons have been called upon with increasing frequency, to treat backache, with or without recurrence of the sciatic pain, in patients who at some time have had excision of an intervertebral disk.[4]

Not infrequently I see patients who have had a disk operation without fusion of the spine, who still complain of backache and occasionally of recurrence of sciatic pain. Many of these patients report that they were temporarily completely relieved of their more severe symptoms, such as the sciatic pain, by the operation. In some instances, the relief has lasted for two or more years. Backache, which may never have been completely relieved, usually became gradually worse, and in a considerable proportion of the patients, the sciatica, in time, also recurred. Roentgenograms have revealed hypertrophic arthritis of the vertebral bodies and articular facets at the level of the disk deficiency.

In 1932, Keyes and I presented in a lengthy report a review of the physiology and pathology of the intervertebral disk. This article included illustrations and a brief mention of the fact that in experimental animals, both dogs and monkeys, arthritis developed routinely following the removal of an intervertebral disk (fig. 1). This evidence from our experiments was irrefutable, but was inadequately presented and apparently ignored by most of those who subsequently became interested in disk surgery. Time required for the development of hypertrophic changes was less in these animals, where the factor of aging occurs in a much shorter span of years than it does in the human subject. My experience, however, has been that the loss of most of an intervertebral disk in the human spine will invariably be followed, in the course of one to five years, by the development of hypertrophic arthritic changes both in the articular facets and along the margins of the contiguous and contacting vertebral bodies.

The following cases illustrate in a degree, what appears to be the typical end result of excision of a herniated intervertebral disk, when the spine is not protected at the time of the original operation by surgical fusion of the laminae of the vertebrae adjacent to the injured or surgically removed disk.

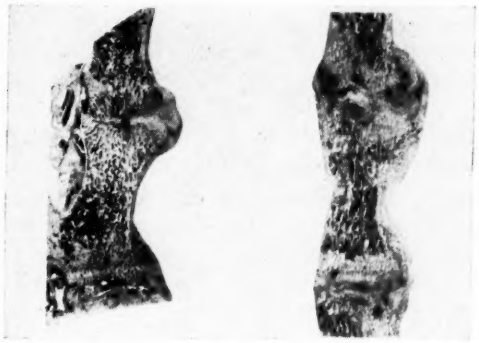

Fig. 1.

The first three of the four cases reported, represent failures of treatment. These were consecutive cases diagnosed by a member of the orthopedic staff. The operation was excision of the ruptured disk without internal fixation by fusion of the spine.

Case 1: J. Z., female, aged 32 years, was examined by me in consultation on October 21, 1938. She complained of backache and right leg sciatica of three years' duration. During this time she had been treated for arthritis. Teeth had been extracted, and diathermy and physiotherapy had been used. Although there were intervals of temporary relief, the right sciatic pain had become increasingly severe. My diagnosis was

that of herniation of the intervertebral disk between the fourth and fifth lumbar vertebrae and possibly of that between the fifth and the first sacral. Dr. Percival Bailey concurred in this diagnosis and on November 5, 1938, carried out an operative procedure in which he found a rupture of intervertebral disk L4–L5. The disk was removed. No attempt was made to fuse the spine. There was immediate relief of the sciatica. A back brace was worn, but nine months after operation this patient still complained of backache and unless a brace was worn there was recurrence of the right sciatic pain.

The pain became more severe and on April 10, 1940, Dr. Earl Walker performed a secondary laminectomy. He did not find any recurrent herniation of the disk. Posterior nerve roots 4 and 5 were sectioned. Dr. C. O. Adams, one of my assistants, then proceeded with an operation for obtaining fusion of the spine. The pain was relieved temporarily and the patient was discharged from the hospital on May 13, 1940, in a short plaster hip spica. She was readmitted, however, three months later because of backache. She was obviously emotionally distressed and wept when pain in the back was discussed. A diagnosis of hysteria was made. This patient has continued to be severely disabled.

The long period of time which elapsed between the onset of symptoms resulting from a herniation of an intervertebral disk, permitted extensive traumatic arthritic changes to occur. A reasonable conclusion, based upon experimental and clinical observations, would be that fusion of the spine before arthritic or neurotic changes had taken place, would have effected a permanent cure and thus have saved this patient from a life of invalidism.

Case 2: E. B., female, aged 24 years, was seen by me in consultation at the Albert Merritt Billings Hospital of the University of Chicago Clinics on December 13, 1938. She complained of pain in her back and pain along the course of the sciatic nerve of the right leg of three years' duration. An earlier diagnosis of chronic sacro-ilioc arthritis and myositis had been made but she had failed to respond to medical management. Physical and roentgenological findings justified a diagnosis of herniation of intervertebral disk L4–L5 and possibly of a similar lesion at L5–S1. I advised operation and suggested fusion at the time of removing the disk. On March 12, 1939, she was examined by Dr. Percival Bailey who agreed with the diagnosis and advised surgical removal of the disk but did not at that time favor spine fusion. The operation was performed by Dr. Earl Walker on March 15, 1939. A definite herniation of intervertebral disk L4–L5 was found and the extruded portion of the disk was removed. The sciatica was immediately relieved and has not recurred. However, she has continued to have backache which has become increasingly severe. When last examined on November 6, 1944, she was, according to the note of the examining physician, "still incapacitated with lumbar backache" in spite of a brace which she had worn consistently. This patient was emotionally well balanced and was obviously in pain and suffering from an organic lesion. Arthrodesis of the spine was advised but the patient did not return.

Case 3: M. F., female, aged 25 years, a graduate nurse, was seen by my associate, Dr. Sam Banks, in consultation on April 12, 1940, at the University of Chicago Clinics. A diagnosis of rupture of intervertebral disk L5 was made and the patient was referred to the

Department of Neurosurgery. Roentgenograms revealed a defect in the lipiodol shadow on the right side at the level of L5–S1. An operation was performed by Dr. Earl Walker on May 3, 1943. The right posterior nerve root at the L5 interspace was found to be compressed against the pedicle. The bulging portion of the disk was removed. This patient last reported to the University of Chicago Clinics on May 19, 1941, approximately one year after operation. She stated that she still had backache and that she still needed her back brace.

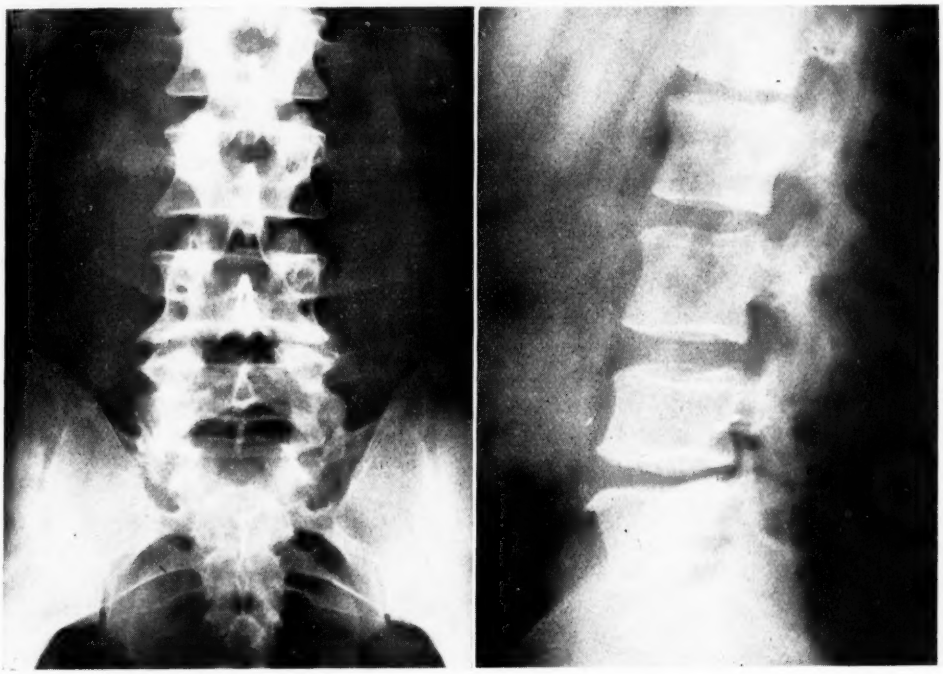

Fig. 2.

Comment: The three cases which have been described are evidence of the fact that the removal of an intervertebral disk without interlaminal fusion to support the spine, may leave the patient with a persistent backache. Sciatica may recur within one to five years if the hypertrophic arthritis becomes marked. Fusion of the spine at the time that the disk is removed is a logical procedure which may be expected to relieve backache and prevent or minimize the late arthritic changes.

Case 4: E. J. D., male, aged 41 years, consulted me January 26, 1945, complaining of backache of three and one half years' duration and of sciatic pain in the right leg. Roentgenograms revealed narrowing of intervertebral disk space L4 and marginal lipping of the vertebral bodies at this level (fig. 2). A diagnosis of rupture of intervertebral disk L4 was made. Upon operation the fourth intervertebral disk was found to be soft and necrotic; it was removed. The articular facets L4–L5 and L5–S1

were partially excised, the defects packed with bone chips. Multiple small bone grafts were obtained from the sacrum, laminae and posterior spinous process. These were placed shingle fashion from sacral 3 to lumbar 4 laminae, forming a thick bed of bone chips that spread across the laminae from the articular facets on one side to those on the other.

Recovery was uneventful. The patient was permitted to return to work wearing a back brace five weeks after the operation. The fusion will not be considered strong enough to permit work at hard labor for at least six months and a back brace will be worn for twelve months.

COMMENT

My observation and experience with patients suffering from a disk syndrome encourage me to hazard several opinions:

1. If the diagnosis of rupture of a disk had been made three years earlier in Case 4, the traumatic arthritis would not then have been demonstrable in roentgenograms.

2. If the disk had been removed and the spine fused shortly after the onset of symptoms of backache and sciatic pain the osteophyte changes on the contiguous portions of L4 and L5 would not have developed.

3. If I had not carried out a fusion between the laminae of the vertebrae showing these changes, they would, with reasonable certainty, have become more marked during subsequent years.

For five years now I have seen an ever increasing number of patients whose backache, and in some instances sciatic pain, had persisted or recurred after they had been operated upon by surgeons who did not consider fusion of the spine advisable after removal of an intervertebral disk. During this five year period I have routinely carried out an interlaminal fusion of the spine of each patient that I have operated upon for the removal of a ruptured disk. In no single instance have I had any occasion to regret this strengthening of the spine in an area which had been weakened through loss of so important a structure as an intervertebral disk. Convalescence is not prolonged by the fusion. Fusion of only two or three laminae which have already been exposed is not a formidable procedure. Since the extent of the fusion is *short* and hence the strain on the area will not be great, no tibial or iliac bone is needed. Smith [5] has reported his results in a series of cases treated by fusion following disk excision.

TECHNIC

The operative procedure which I have used is as follows:

1. The laminae at the level of the injured disk are exposed subperiosteally through a longitudinal midline incision. Most often this means exposing laminae L3 to S3.

2. The ruptured disk is removed after excising the ligamentum flavum and separating the laminae.

3. Immediately adjacent disks are then exposed in the same manner and examined to confirm or rule out the presence of additional disk protrusions.

4. The fusion is planned to include only the laminae of the vertebrae contiguous to the disk which has been removed, and, if at L4 or L5 level, to the sacrum.

5. The technic is essentially as described by Hibbs. However, only the posterior half of the articular facets are excised. Complete excision weakens the spine and is not necessary in obtaining arthrodesis. Bone chips are packed into the defect in the facets. Many bone

shavings, chips, or splinter grafts are then removed from the sacrum, laminae and posterior spinous processes. These are placed across the laminae so that they lie one over the other "shingle fashion" and several layers thick.

6. The patient is kept on a turning frame or hard bed for two weeks. No cast is required.

7. On the fourteenth day after operation the patient is permitted to be out of bed, wearing a strong back brace of the Magnuson or Williams type.

8. By the end of the third postoperative week he should be ready for discharge from the hospital.

DISCUSSION

The first three patients referred to in this report were operated upon by competent neurosurgeons. At the time of the initial operation no fusion was done. Case 1 was reoperated and an arthrodesing procedure was carried out after she had again become disabled with pain in the back and sciatica. However, by this time she had acquired a psychopathic personality and has never recovered sufficiently to be able to live a normal life. The unsatisfactory results of excision of a ruptured disk without simultaneous fusion of the laminae confirmed my opinion, based upon knowledge of the function of the intervertebral disk, that fusion should always be carried out at the time of removing the disk substance. Since 1940 I have advocated and consistently practiced interlaminal spine fusion in each instance in which a herniated or ruptured disk was removed. Failure to carry out this combined operation is fully as serious an error of judgment as that which was once common practice among orthopedic surgeons, namely, lumbosacral fusion without exploration of the disk.

SOMMAIRE

La structure et la fonction du disque intervertèbral et les causes de rupture sont dérités. Le traitement précoce de rupture est détaillé. L'auteur fait aussi allusion à ses rapports antécédents de recherches faites sur des animaux. Il este de cas avec fission et sans fusion observes lors de lablation d'un disque hernié. Il décrit la technique opératoire et aussi le traitement post-opértoire auquels il a recours dans les cas de cette nature.

RESUMEN

En el trabajo que resumimos se describe la estructura y objeto del disco intervertebral, conjuntamente con las causas que originan su ruptura. Se bosqueja la terapéutica precóz de dicha ruptura, haciendo referencia de los experimentos previos del autor en animales. Se mencionan varios casos con y sin fusión en el momento de resecar el disco herniado. Se hace la descripción de la técnica operatoria y se detallan asimismo los cuidados post-operatorios.

Свод

Описано строение и значение межпозвоночного диска, а также даны причины его грыжи. Кратко описано раннее лечение грыжи диска. Сделана ссылка на прежние доклады автора об экспериментальной работе над животными. Даны примеры случаев как со слиянием, так и без слияния позвоночников ко времени удаления грыжевого диска. Описаны оперативная методика и послеоперативный уход.

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Osteotomy for the Treatment of Ununited Fracture of the Femoral Neck

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FOR the surgeon who treats fractures, one of the most difficult and distressing problems for solution is the elderly patient with a nonunion of the neck of the femur. Even in the most skilled hands, with the best and most modern forms of treatment, many failures occur as shown in a recent study by a committee of the American Academy of Orthopedic Surgeons in 1939, who studied a series of 1,485 cases of fresh fractures of the femoral neck. Of these, nonunion was present in 173, or 16.4 per cent; and deaths 127, or 8.5 per cent; necrosis, or absorption of the femoral neck numbered 127, or 8.5 per cent. However, the number of similar cases treated inadequately, or undiagnosed and untreated, would considerably increase these percentages of failure. Before the present methods of internal fixation and reduction, the estimates of nonunion were from 53 per cent to 75 per cent, which lead a prominent foreign surgeon, in an oration on fracture to classify femoral neck fractures as the "unsolved fracture." Many ingenious procedures have been devised by the more enterprising and aggressive orthopedic surgeons to overcome nonunion, which are sound in mechanical principles and which overcome the extreme disability and its attendant symptoms.

The primary disability in these cases is due to the instability of the hip, with limp, pain in varying degree, and the Trendelenberg sign.

As quoted by Gaenslen, of Milwaukee, Schanz in 1922 described the mechanism of the unstable hip due either to a congenital dislocation or nonunion as the Trendelenburg phenomenon. "The step begins with the lifting of the heel, the bending of the knee and the dropping of the pelvis on the sound side. The pelvis sinks until the lower rim of the pelvic funnel impinges upon the femur. Not until this impingement takes place is the conversion of the pelvis and the femur into a weight bearing unit complete, and not until then can the toes be raised from the ground and the foot advanced. The step may be divided, therefore, into two phases: a first or dead phase, with effort wasted; and a second or active phase, serving progression. Elimination of the dead phase by

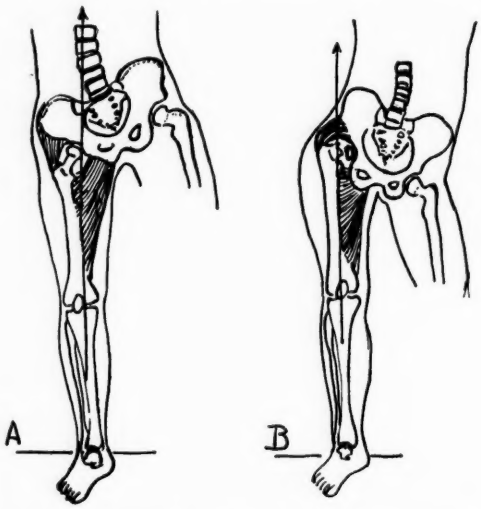

Fig. 1.—Trendelenberg sign (after Watson Jones). *A* Normal line of weight-bearing, standing on one leg. *B* Line of weight-bearing after nonunion, showing dip of pelvis on normal side. Both true and apparent shortening are increased.

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conversion of the pelvis and the femur into a weight bearing unit at the moment the step begins results in better performance. This can be accomplished by osteomy and angulation in such a manner as to result in marked improvement

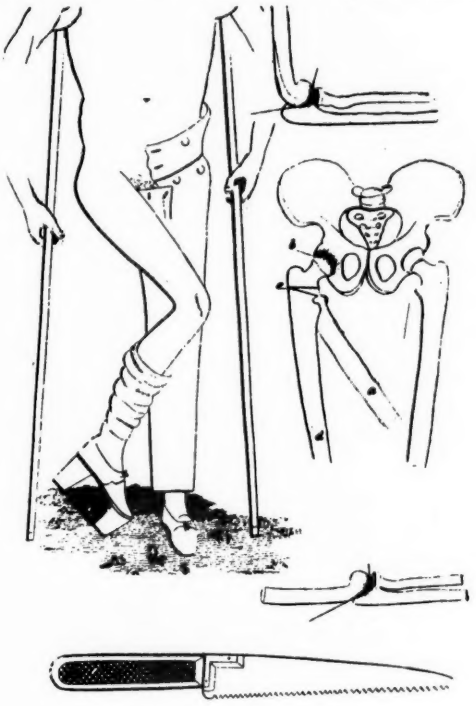


Fig. 2.—Early case (1826) of flexed and adducted thigh with ankylosis of hip.

in gait with resultant lessening of pain and fatigue."

Many, if not most, of the cases have an external rotation of the thigh with an adduction of the leg, instability of the knee, and usually can only walk with the aid of crutches, or, at best, a cane. The weight thrust on the affected side is hurried and there is a lurch of the whole body. Following the gradual absorption of the femoral neck, a coxa vara develops and the deformity causes a shearing effect upon the fracture surfaces. Many times the femoral head becomes necrotic from circulatory changes and the gluteii become shortened, relaxed and atrophied, while the powerful adductors as well as the hip flexors become contracted.

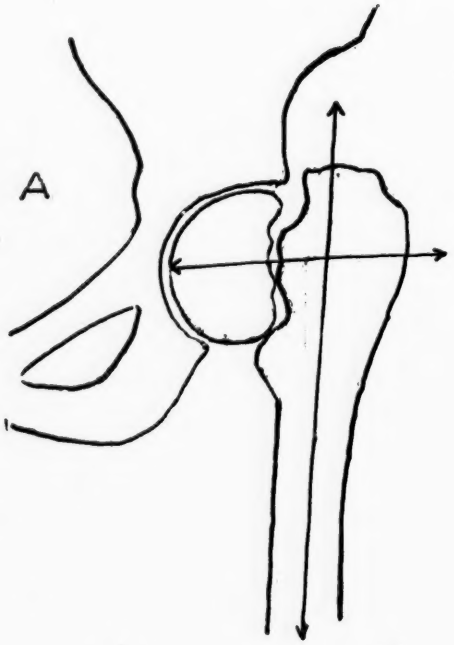
In order to overcome such a condition, many surgical procedures have been devised. In suitable cases, a bone peg can be used as described by Albee. Reconstruction procedures have been devised by Whitman, Colonna, Albee and others. A method of relieving the condition by restoring proper mechanical stability and even securing union, is by a trans-trochanteric osteotomy. This procedure to correct the weight transmission from the femur through its insecure upper end to the acetabulum, pelvis and spine, is sound in its physiological and kiniseological concept. Watson Jones gives the following classification of operative procedures: with

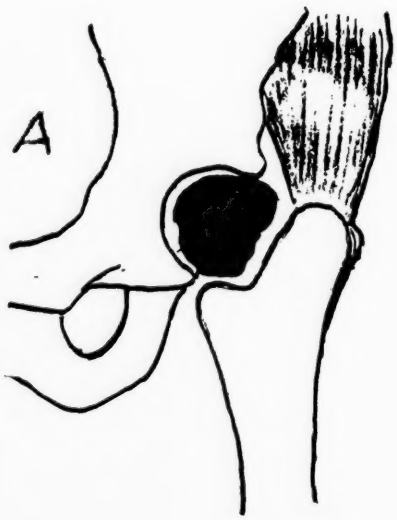
A. Minimal absorption of neck and live head;
   1. Abduction osteotomy to produce valgus impaction of fragments
   2. Drilling and nailing of neck, or
   3. Bone grafting and nailing of neck

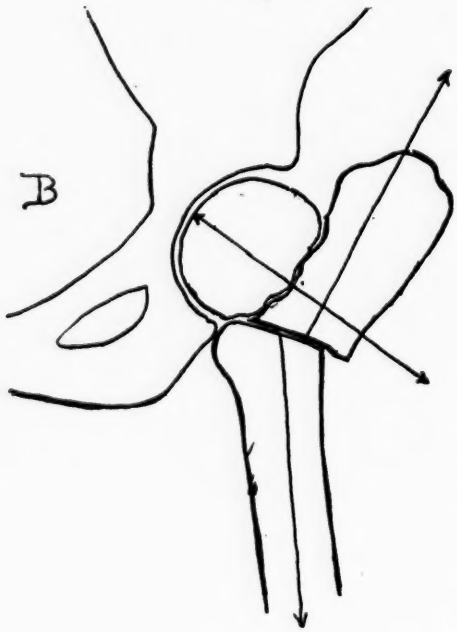
B. Maximal absorption of neck and dead head;
   1. Whitman, Colonna and Albee reconstruction

C. Minimal or maximal absorption of neck and live or dead head;
   1. Lorenz bifurcation operation.

The historical background of trans-trochanteric osteotomy, in its development to its present day application in cases of nonunion of the femoral neck is interesting. In the early Eighteenth Century, before x-rays, anesthesia or aseptic surgery, early records indicate







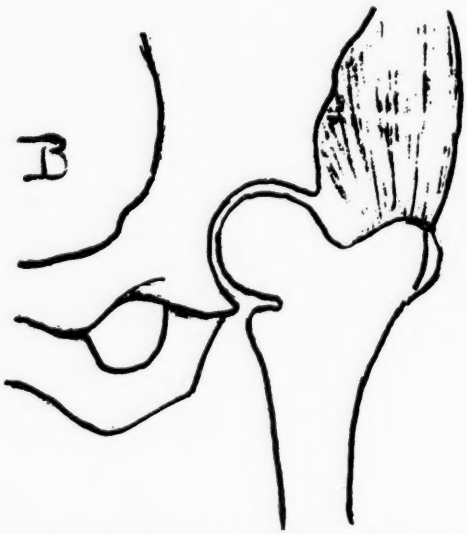


Fig. 3.—*A* Tracing of film showing angles of shearing stress and coxa vara. *B* Tracing of film following osteotomy showing changes to relieve lines of stress favoring tendency for union.

Fig. 4.—*A* Osteotomy forming an arthroplasty with a necrotic femoral head. *B* Osteotomy with union of fracture, relief of pain and excellent function.

hip surgery, such as resection of the hip joint for deformity of the femur, was done by Jean Morand in 1739. However, the first surgeon to perform a trochanteric osteotomy was our own American

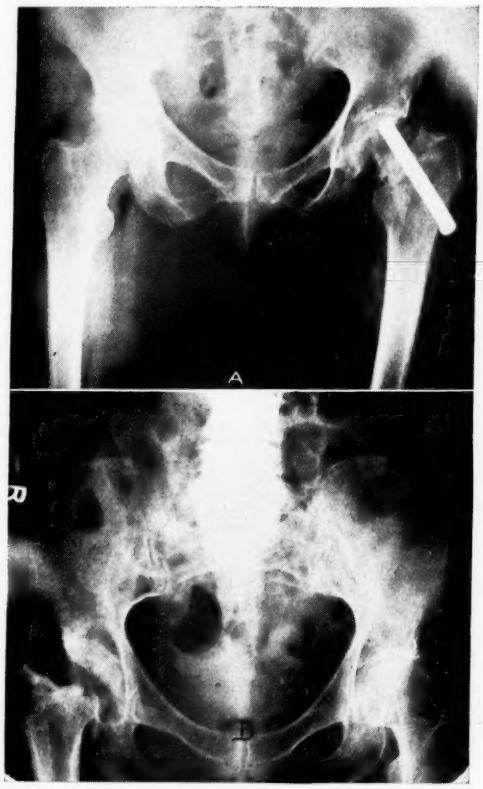


Fig. 5.—*A* Preoperative nonunion and marked necrosis of femoral head—Case 1. (Print reversed.) *B* Same case, one year after operation; result, stable arthroplasty.

surgeon, J. Rhea Barton, who reported in detail, including a sketch. His case was a young sailor with a flexed and adducted thigh, with ankylosis of the hip following an injury (fig. 2). Barton's idea was to perform an osteotomy and produce a pseudoarthrosis, enabling motion to occur; and apparently he obtained a good result. One must admire his reasoning and his originality in carrying out the procedure which was done at the Pennsylvania Hospital, November, 1826, and reported in the North American Medical and Surgical Journal in 1827. Leufthaben, in 1858, made the first resection of the femoral head for treatment of pseudoarthrosis. Gant reported in 1872, an osteotomy for an ankylosis of the hip. Improvements and modifications followed by Kirmisson in 1894, Lorenz in 1919 and Shanz in 1922. Both high and low types were used for congenital instability as well

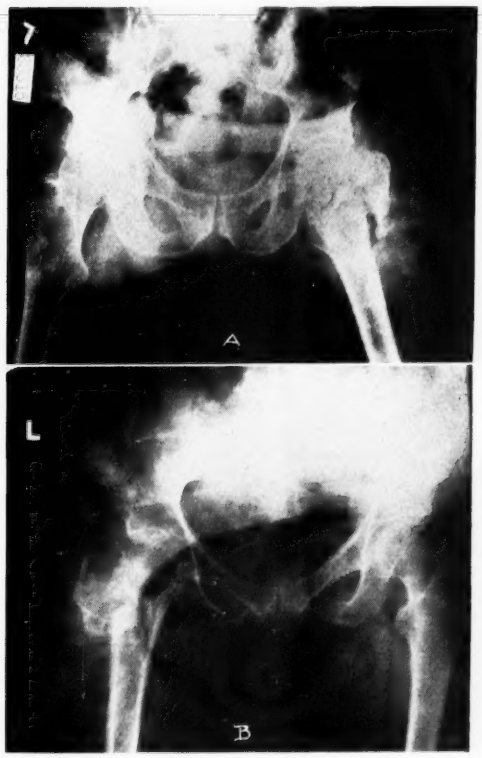


Fig. 6.—*A* Postoperative position. *B* Same, in plaster spica.

as pseudoarthrosis. More recently, the principles of the modified osteotomy were brought to our attention by

McMurray, Putti and Gaenslen and Schumm.

In selected cases, we have used Albee's technique of bone graft, maintaining additional fixation with a Smith-Peterson nail with good results. However, the group of patients here reported were elderly and generally poor operative risks, ranging in age from 59 to 86, many with aseptic necrosis of the head of the femur. Several of these cases developed rapid absorption of the femoral neck in spite of accurate reduction and internal fixation. All these cases were considered unfavorable for more serious surgical procedures, such as fusion or reconstruction.

Fig. 7.—One year after operation; result, stable fibrous union.

The type of oblique osteotomy used, is classified as the high, or intertrochanteric, as described by McMurray in 1936. The site of the division is from a point just below the greater tronchanter upward to a point just above the lesser, with a medial displacement of the distal fragment under the femoral head. The proximal fragment becomes adducted and angulated with its important muscular attachments. This procedure restores the general contours of the hip joint with elimination of the adducted shaft of the femur and shearing stress which is associated with the nonunion. The body weight and thrust of the leg tend to aid in union rather than to cause

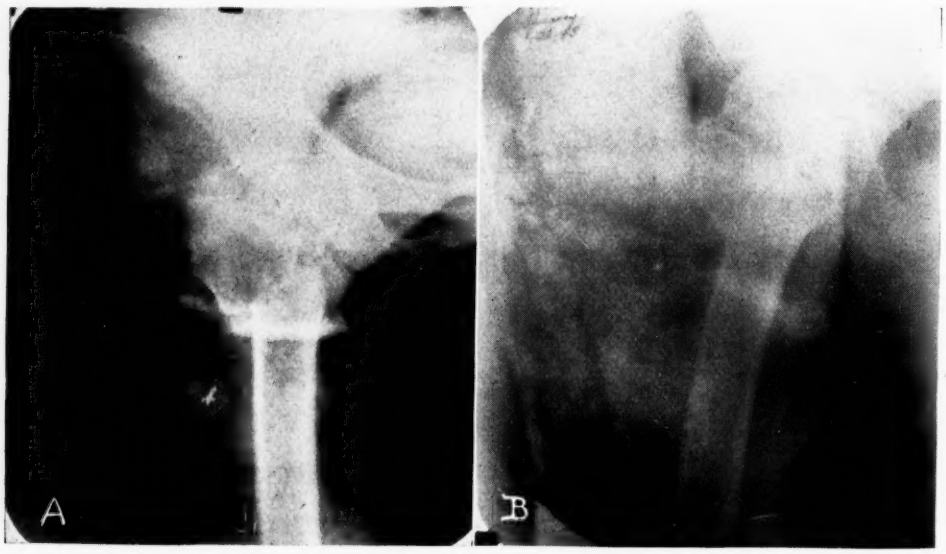


Fig. 8.—*A* Three months after operation; solid union. *B* Same patient, lateral view.

or prolong the nonunion and absorption of the fractured surfaces of the femoral neck. A double plaster spica is used with mobilization of the knee on the affected side as soon as consistent with healing and the unaffected side is released in eight weeks, the entire cast in ten weeks, release being followed by exercises and physical therapy. All cases showed some limited hip motion, mostly internal rotation. Hip flexion to 90 degrees or more was obtained. Stability was uniformly satisfactory with the elimination of most of theTrendelenburg symptoms. In all but two cases, pain was minimal and increased the distances patients could walk without fatigue. Two patients with non-vital femoral heads showed increased absorption, but the arthroplastic effects were satisfactory from a functional angle. No deaths occurred in the series and the shock of the operation was short in duration and mild in degree. Most marked improvement was the absence of pain, and the preoperative discomfort of the unstable hip. Complications were slight. One case showed respiratory embarrassment due to showers of pulmonary emboli.

SUMMARY

Case	Age	Sex	Duration nonunion	Shortening	Union	Result	Complications	Averages
1	71	F	17 mos.	3.5 cm.	absorption head	good	none	Age 72
2	88	F	5 mos.	3.8 cm.	absorption	fair	none	
3	74	F	8 mos.	3.0 cm.	absorption	fair–arthritis	none	Shortening 3 cm.
4	65	F	3 mos.	2.5 cm.	solid	excellent	none	
5	66	F	6 mos.	2.8 cm.	solid	excellent	none	
6	86	M	4 mos.	2.8 cm.	solid	excellent	none	Sex males 3 females 11
7	72	F	7 mos.	2.5 cm.	solid	excellent	none	
8	73	F	22 mos.	3.0 cm.	solid	good arthritis	none	Solid Union 64.28%
9	65	F	10 mos.	2.8 cm.	solid	excellent	none	absorption 35.71%
10	62	F	8 mos.	3.0 cm.	solid	good hemiplegia	none	
11	59	M	14 mos.	2.8 cm.	solid	fair–arthritis	none	Results excellent 35.7%
12	78	M	5 mos.	2.8 cm.	solid	good hemiplegia	none	good 35.7% fair 28.6%
13	71	F	14 mos.	3.7 cm.	absorption head	good arthritis knee	pulmonary emboli recovery	Duration nonunion 9.4 mos.
14	79	F	9 mos.	3.5 cm.	fibrous arthritis	fair	none	

(Continued on page 35)

Bone Grafts for Ununited Fracture of the Neck of the Femur

A Report of Ninety Cases

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IN 1913, the late Dr. Fred Albee[1] mentioned a woman, sixty years of age, whose fractured hip had remained ununited for three and a half months. At open operation on this patient a bone graft, in the shape of a dowel, was employed. Later, Doctor Albee commented[2] on the successful result in this case. As far as we can ascertain, this is the first mention in the literature of a bone graft being used in this manner. Doctor Albee discovered early in his experience that a bone graft was not applicable in all cases of nonunion of the neck of the femur. As a consequence, later he developed his reconstruction operation. Herein we shall present, as a tribute to Doctor Albee's pioneer work, results obtained at the Mayo Clinic with the bone graft in treatment of ununited fracture of the neck of the femur. However, before we record the series of cases from the clinic we shall devote a few paragraphs to general discussion.

SELECTION OF CASES

The general health of the patient and the condition at the site of fracture must be favorable if a bone graft is to be used. Sometimes conditions at the site of fracture are satisfactory but the general health of the patient is not, or vice versa. The patient must have a reasonable expectancy of life and his health must be such that a major surgical procedure will be tolerated. Obese patients are not good subjects.

Conditions at the site of fracture which are most important to consider are two:

1. If the head of the femur is necrotic, or if its blood supply is markedly deficient, a bone graft should not be used. However, even with the site of fracture exposed, often fine judgment is required to determine whether the head is sufficiently viable to warrant insertion of a bone graft or whether, instead, the head should be removed and one of the reconstruction operations should be performed. Poor late results, in which atrophy and flattening of the head occur, can be attributed to lack of nourishment of the head.

2. A sufficient portion of the femoral neck must be available to allow accurate fitting of the head to the neck. Good roentgenograms, taken both from the lateral and from the anteroposterior aspects, will give definite information as to the size and shape of the neck. If a good portion of the neck of the femur remains and the head is viable, union, with anatomic restitution and normal function, is attainable.

TYPE OF OPERATION

Definition.—There are two ways in which the bone graft can be inserted:

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1. In articular osteosynthesis, the joint is opened, the site of fracture is examined, the fragments are freshened and fitted and the bone graft is inserted.
2. In extra-articular osteosynthesis, the fragments are placed in correct alinement, a small lateral incision is made and the bone graft is inserted through a tunnel which has been drilled through the neck and well into the head. In the United States, this method is sometimes spoken of as "blind insertion," an unfortunate term, because the procedure is by no means done blindly but under full roentgenographic control.

Technic of the open method (articular osteosynthesis).—This procedure will be presented in numbered steps:

1. The Smith-Petersen approach is used with the exception that the skin incision is different. The incision we prefer is elliptical with the base upward and the convexity extending well down to the region of the trochanter. The skin flap is dissected upward and pulled inward, thus keeping the skin of the groin which is a possible source of infection out of the field entirely (fig. 1*a*).

2. The capsule is opened (fig. 1*c*) and much of it is dissected away, exposing the line of fracture. The fibrous tissue is dissected from between the fragments and these fragments are freshened and fitted.

3. Under visual control, a Kirschner guide wire is inserted into the femur,

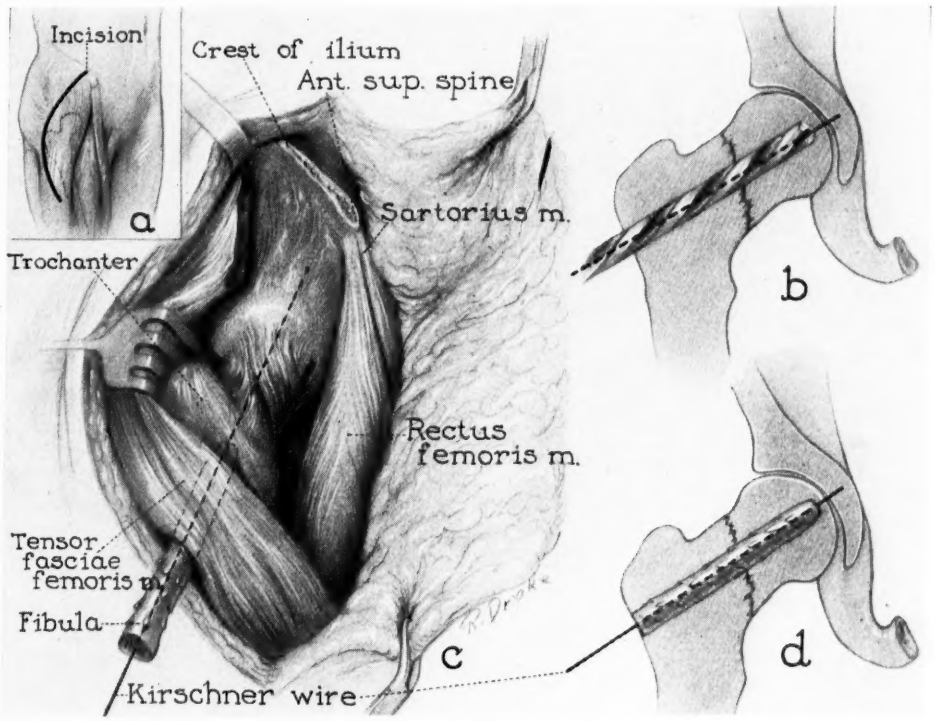


Fig. 1.—Technic of articular osteosynthesis: *a.* incision; *b.* drill through bone over Kirschner wire; *c.* exposure and beginning of insertion of bone graft over Kirschner wire; *d.* insertion of bone graft over Kirschner wire.

just below the trochanter, and is thrust up through the neck and into the head. It should be placed sufficiently deep to engage the acetabulum and thus steady the head (fig. 1*d*). A cannulated drill is then sleeved over the wire (fig. 1*b*), and a tunnel, of such a size that the fibular graft will fit snugly, is made well into the head (fig. 1*d*).

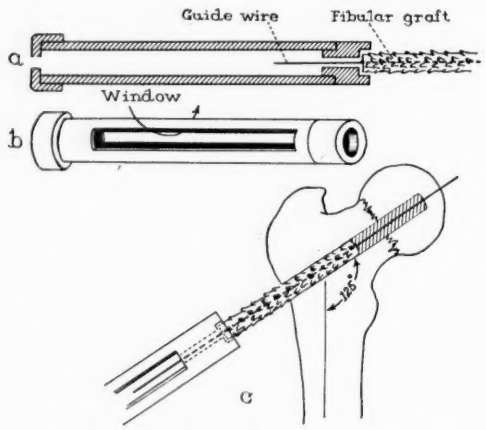


Fig. 2.—Impactor used for driving in fibular graft.

4. The bone for the graft is removed (preferably by a second operating team) usually from the fibula of the affected leg. All muscle and periosteum are scraped away and the cortex is thoroughly freshened with a chisel. This last is an important step, as it enables a blood supply to enter the graft more readily than otherwise.

5. The bone graft is inserted over the wire (fig. 1*d*) and is pounded in to the proper depth (fig. 2). The fragments are impacted firmly; then the guide wire is removed.

6. A double spica cast is applied, extending from the thorax to the toes on the affected side and from the thorax to the knee on the opposite side. It is worn for three months.

7. If the roentgenographic appearance is satisfactory, the patient is allowed to be about on crutches after three months, rarely before. Weight bearing is not permitted for six months, and preferably not until shadows of bone trabeculae can be seen crossing the line of fracture.

Technic of the closed method (extra-articular osteosynthesis [10]).—The essential preliminaries to this operation, as well as to articular osteosynthesis, are proper alinement of the fragments and obliteration of all shortening, so that the graft will not be subjected to strain or shearing force during the period of healing. Shortening can be overcome by traction, preferably applied in the preoperative period or, if arthrotomy is done, it can be combated by dividing the tight structures at operation. The technic of extra-articular osteosynthesis is briefly as follows:

1. A short, lateral incision exposes the shaft of the femur just below the trochanter (fig. 3*a*).

2. A Kirschner guide wire is inserted as nearly as possible in the normal line, that is, at an angle of 127 degrees with the shaft and with forward angulation of approximately 15 degrees. This is the ideal position but, if conditions at the site of fracture are such that this normal angulation cannot be secured, then the direction of the inserting Kirschner guide wire will have to be changed to fit the case. This procedure is done under roentgenographic control and the number of wires inserted is kept at a minimum. Some authorities advise the somewhat indiscriminate insertion of a large number of wires and then picking out the one in the best position. Such a procedure often leads to unnecessary trauma to the bone structures in the neck and head of the femur.

3. Over the wire is sleeved a cannulated twist drill of proper size and the tunnel for the graft is drilled (fig. 3*b*).

4. The graft is then inserted over the wire and is pounded in to the proper depth (fig. 3*c* and *d*). The bone graft must be prepared as described under articular osteosynthesis. The fragments are impacted and the guide wire is removed.

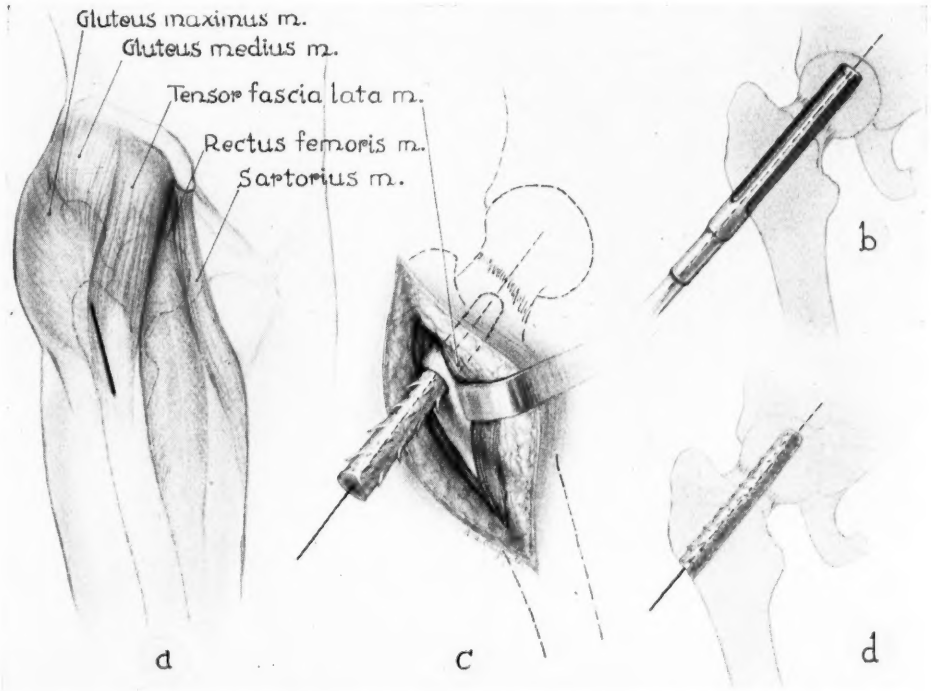


Fig. 3.—Anatomic relations of incision and bone graft. Note *a* the incision at the base of the trochanter; *b*. the fibular bone graft cleansed of all muscle, thoroughly roughened and partially inserted in the tunnel prepared for it; *c*. the cannulated drill inserted over a guide wire, and *d*. the fibular bone graft in the proper position.

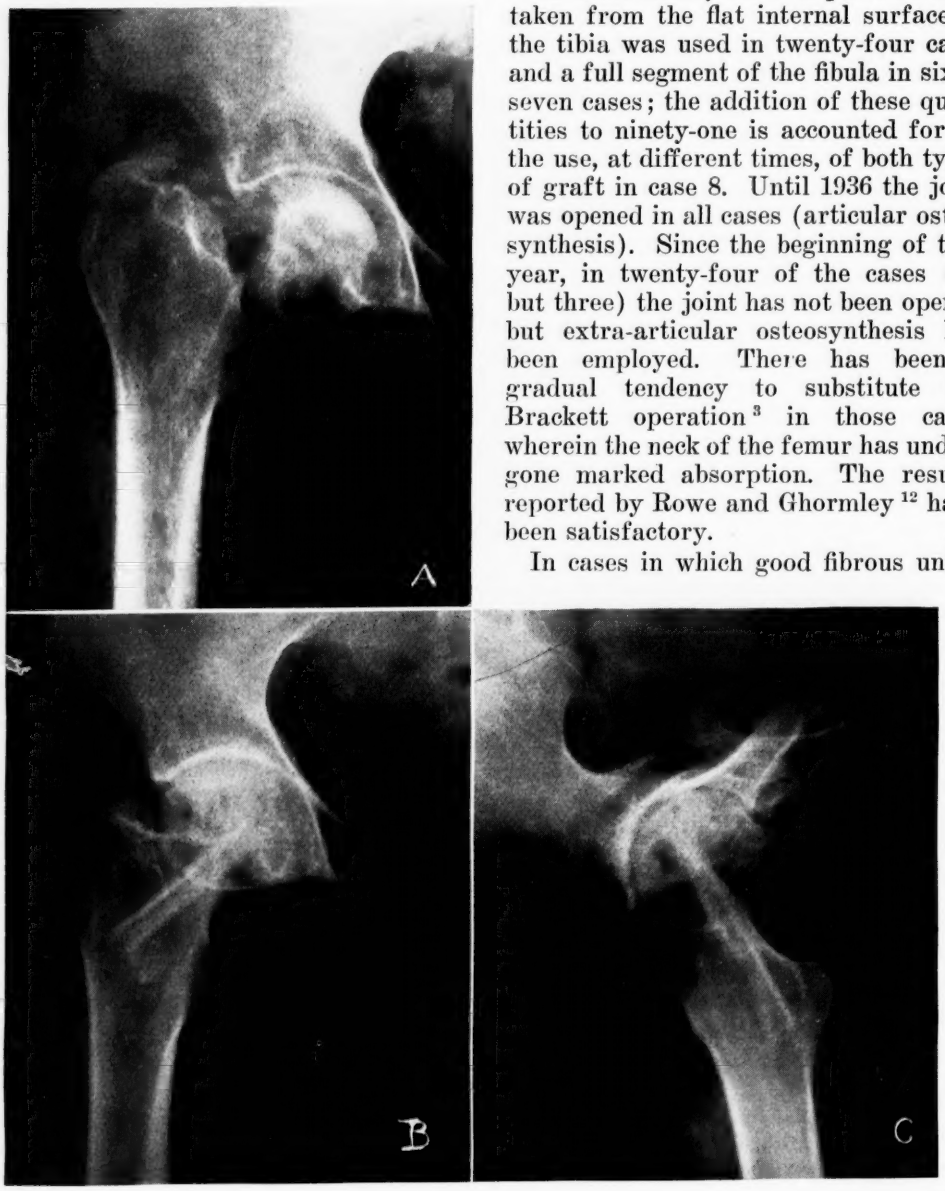
5. A double spica cast is applied and the same postoperative care is given as in cases in which articular osteosynthesis is performed. Recently the period of fixation in the cast has been shortened by several weeks (figs. 4*A* and *B*).

MAYO CLINIC SERIES AND RELATED COMMENT

In the thirty-two years from July, 1913, to June, 1945, inclusive, a bone graft was used for treatment of ununited fracture of the neck of the femur in ninety cases (tables 1 and 2). In the designated period, actually only one in ten of the patients admitted for ununited fracture of the neck of the femur was subjected to the procedure under discussion. A fracture of the neck of the femur was assumed to be ununited if, at the end of three months following the accident, evidence of repair could not be demonstrated clinically or roentgenographically. In this series, the longest period during which nonunion had existed prior to operation was eighty-four months; the shortest period was three months; the average was 12.7 months. Forty-five of the patients were males and forty-five, females. The oldest patient was seventy-three years of age and the youngest, nineteen. In decades

of life, the distribution was as follows: one patient in the second decade, five patients in the third, sixteen patients in the fourth, twenty-one patients in the fifth, thirty-seven patients in the sixth, eight patients in the seventh and two patients in the eighth.

Fig. 4.—*A* Nonunion of neck of femur of ten months' duration. *B* Same patient three and a half years after insertion of bone graft. *a*. Anteroposterior view; *b*. lateral view.



In these ninety-cases a piece of bone taken from the flat internal surface of the tibia was used in twenty-four cases and a full segment of the fibula in sixty-seven cases; the addition of these quantities to ninety-one is accounted for by the use, at different times, of both types of graft in case 8. Until 1936 the joint was opened in all cases (articular osteosynthesis). Since the beginning of that year, in twenty-four of the cases (all but three) the joint has not been opened but extra-articular osteosynthesis has been employed. There has been a gradual tendency to substitute the Brackett operation [3] in those cases wherein the neck of the femur has undergone marked absorption. The results reported by Rowe and Ghormley [12] have been satisfactory.

In cases in which good fibrous union

TABLE 1 *

SUMMARY OF SEVENTY-SEVEN CASES IN WHICH UNUNITED FRACTURE OF THE NECK OF THE FEMUR WAS TREATED BY BONE GRAFT †

Case	Duration of nonunion before operation, mo.	Age, years	Sex	Date of operation	Type of graft	Result	Date of last observation
1	12	49	Male	July 16, 1913	Tibial	Failure	1933
2	3	39	Male	Aug. 20, 1913	Tibial	Union	1917
3	12	53	Male	May 21, 1914	Tibial	Union	1923
4	21	30	Female	Oct. 26, 1914	Tibial	Not traced	
5	22	55	Male	Dec. 4, 1914	Tibial	Union	1915
6	5	51	Male	Dec. 10, 1914	Tibial	Failure	1921
7	10	51	Male	Apr. 20, 1915	Tibial	Failure	1917
8	3	36	Female	Aug. 19, 1915 Apr. 26, 1917	Tibial Fibular	Failure Failure	1921
9	3	46	Male	Aug. 2, 1916	Tibial	Failure	1918
10	12	39	Male	Jan. 11, 1917	Fibular	Failure	1921
11	20	32	Male	May 17, 1917	Fibular	Union	1921
12	13	59	Male	June 14, 1917	Fibular	Failure	1921
13	11	33	Male	July 25, 1917	Fibular	Union	1921
14	5	25	Female	Feb. 28, 1918	Fibular	Failure	1918
15	6	54	Male	Sept. 20, 1918	Fibular	Failure	1920
16	11	53	Female	Apr. 9, 1920	Fibular	Not traced	
17	5	42	Male	Jan. 5, 1920	Fibular	Union	1921
18	10	30	Female	Jan. 6, 1920	Fibular	Union	1936
19	6	53	Male	Apr. 15, 1920	Fibular	Union	1921
20	4½	35	Female	Mar. 12, 1920	Fibular	Union	1924
21	10	37	Male	Sept. 9, 1920	Fibular	Union	1924
22	42	28	Female	Oct. 26, 1920	Fibular	Not traced	
23	22	58	Male	Jan. 17, 1921	Fibular	Union	1938
24	7	52	Female	Jan. 31, 1921	Fibular	Died 2 weeks after operation	
25	8	53	Male	Feb. 23, 1921	Fibular	Union	1925
26	19	21	Male	Mar. 18, 1921	Fibular	Union	1931
27	24	55	Male	Sept. 19, 1921	Fibular	Failure	1929
28	17	35	Male	Nov. 9, 1921	Fibular	Union	1925
29	5½	50	Female	Aug. 17, 1922	Fibular	Union	1938
30	24	40	Male	Mar. 18, 1922	Fibular	Union	1922
31	3	57	Male	June 20, 1922	Fibular	Not traced	
32	5	40	Male	Nov. 3, 1922	Fibular	Failure	1929
33	36	52	Male	Feb. 5, 1923	Fibular	Union	1938
34	27	39	Female	Mar. 19, 1923	Fibular	Union	1925
35	12	32	Male	Sept. 6, 1923	Fibular	Union	1939
36	20	49	Female	Jan. 7, 1924	Fibular	Union	1925
37	9	52	Male	Oct. 7, 1924	Fibular	Union	1925
38	23	44	Female	June 18, 1925	Fibular	Union	1937
39	3	50	Female	May 6, 1926	Fibular	Union	1938
40	18	37	Female	Sept. 30, 1926	Fibular	Union	1937
41	8	21	Female	Nov. 11, 1926	Fibular	Union	1933
42	9	49	Female	Jan. 11, 1927	Tibial	Failure	1929
43	18	42	Male	Nov. 25, 1927	Fibular	Failure	1929
44	13	52	Female	June 21, 1928	Tibial	Union	1934
45	7½	53	Female	Sept. 27, 1928	Tibial	Union	1935
46	6	19	Male	Jan. 14, 1929	Tibial	Union	1929
47	9	48	Male	Feb. 4, 1930	Tibial	Union	1935
48	9	44	Male	Apr. 29, 1930	Tibial	Union	1934
49	8	46	Male	Mar. 31, 1930	Fibular	Union	1934
50	12	54	Male	July 5, 1930	Tibial	Union	1931
51	9	39	Male	Nov. 13, 1930	Tibial	Union	1934
52	22	55	Female	Jan. 16, 1931	Tibial	Failure	1934
53	7	54	Female	Apr. 28, 1931	Tibial	Failure	1933
54	11	48	Female	Jan. 15, 1931	Tibial	Failure	1934
55	21	44	Male	July 4, 1931	Fibular	Union	1936
56	5	38	Female	Aug. 30, 1932	Tibial	Union	1934
57	27	53	Female	Jan. 26, 1934	Tibial	Union	1937
58	25	42	Male	May 28, 1934	Tibial	Union	1936
59	18½	52	Female	June 30, 1934	Fibular	Union	1939
60	5½	46	Female	July 27, 1934	Fibular	Union	1937
61	9	58	Male	Sept. 26, 1934	Fibular	Not traced	
62	23½	42	Female	Jan. 24, 1935	Fibular	Died 3 weeks after operation	
63	5½	56	Female	Dec. 26, 1935	Fibular	Union	1938
64	7	67	Female	June 20, 1936	Fibular	Union	1940
65	6	57	Female	Sept. 25, 1936	Fibular	Union	1938
66	8½	58	Female	Sept. 24, 1936	Fibular	Failure	1937
67	13	51	Male	Oct. 28, 1936	Fibular and lag screw	Union	1940
68	10	43					
68	10	43	Female	Oct. 27, 1936	Fibular and lag screw	Union	1940
69	10	64	Male	Apr. 6, 1937	Fibular	Union	1945
70	5	50	Male	Nov. 27, 1937	Fibular	Union	1939
71	5	63	Female	July 31, 1937	Fibular	Failure	1940
72	7	67	Female	July 15, 1938	Fibular	Union	1945
73	10	52	Female	Sept. 21, 1938	Fibular	Union	1940
74	5	28	Female	Oct. 25, 1938	Fibular	Union	1942

TABLE 1
(Continued)

Case	Duration of nonunion before operation, mo.	Age, years	Sex	Date of operation	Type of graft	Result	Date of last observation
75	84	49	Male	Jan. 5, 1939	Fibular	Union	1940
76	3	57	Female	Jan. 10, 1939	Fibular	Union	1944
77	5	62	Female	Apr. 25, 1939	Fibular	Union	1944

* Much of this table appeared in Henderson, M. S.: Ununited Fracture of the Neck of the Femur Treated by the aid of the bone graft. J. Bone and Joint Surg. n.s.22:97–106 (Jan.) 1940.
† See table 2 for cases 78 to 90 inclusive.

TABLE 2

SUMMARY OF THIRTEEN ADDITIONAL CASES IN WHICH UNUNITED FRACTURE OF THE NECK OF THE FEMUR WAS TREATED BY BONE GRAFT

Case *	Duration of nonunion before, operation, mo.	Age, years	Sex	Date of operation	Method	Type of graft	Result	Date of last observation
78	21	41	Male	June 30, 1939	Extra-articular	Fibular	Indeterminate	1939
79	6½	59	Female	Oct. 4, 1939	Intra-articular and extra-articular	Fibular	Union	1943
80	4	46	Female	Oct. 12, 1939	Extra-articular	Fibular	Union	1943
81	8	70	Female	Apr. 23, 1940	Extra-articular	Fibular	Union	1942
82	3	51	Female	Apr. 9, 1941	Smith-Petersen nail and extra-articular	Fibular and Smith-Petersen nail	Union	1941
83	4	32	Male	June 15, 1943	Extra-articular	Fibular	Union	1944
84	32	51	Female	Oct. 2, 1943	Extra-articular	Fibular	Union	1944
85	16	56	Male	May 17, 1944	Extra-articular	Fibular	Union	1945
86	19	73	Male	Aug. 16, 1944	Extra-articular	Tibial	Union	1945
87	5½	62	Female	Aug. 30, 1944	Extra-articular	Fibular	Union	1945
88	5½	67	Female	Sept. 11, 1944	Extra-articular	Fibular	Union	1945
89	14	63	Female	May 18, 1945	Extra-articular	Fibular	Indeterminate	Still under observation
90	9½	54	Male	May 23, 1945	Extra-articular	Fibular	Indeterminate	Still under observation

* See table 1 for cases 1 to 77 inclusive.

exists, even though shortening and deformity may be present, if the deformity can be corrected by either skin or skeletal traction, and if the femoral head is viable, extra-articular osteosynthesis in the manner described, really is the preferable procedure. In addition to the advantage of excellent functional results, this procedure is not accompanied by surgical shock. Moreover, it is possible to use the bone graft successfully in treatment of older patients, if this method is used.

In the last report on this series of cases, made in 1940,[9] the average age of the patients was recorded as forty-six years. In contrast, in the thirteen cases reported for the first time in this paper (table 2), the average age at the time of operation was fifty-six years; the oldest patient was seventy-three years of age. Of these thirteen patients only was subjected to the intra-articular, or open, method. Two patients of those subjected to operation before April, 1940, died of emboli soon after the surgical procedure. To the time of writing of this paper (August, 1945) no other deaths had occurred. This is an overall mortality rate of 2.2 per cent.

Davison,[5,6] in 1915 and 1918, pointed out the advantages of the fibular graft over the tibial graft. At the clinic this view is supported, and bone from the

fibula has been used as the graft in the majority of cases. It is interesting that from 1912 to 1918 results were satisfactory in such a small portion of cases encountered at the clinic (33 per cent) that the procedure was abandoned for nearly two years. Since that time, union has been obtained in 81 per cent of cases, patients not traced and those who died soon after operation omitted from the calculation. This result is due, we believe, to increased care in selection of cases and improved technic. For the entire series except, again, those patients not traced and those who died soon after operation were omitted from the total, the number of cases in which union was obtained represents 73 per cent.

Several authors, among whom are Compere and Lee, King, Dickson and Gallie and Lewis, have advocated use of some sort of metallic device for fixation in addition to the bone graft. Of the series of cases on which this report is based, metal fixation has been used in conjunction with the bone graft in three cases. However, the placing of a nail in addition to a bone graft, in a femoral head that is in subnormal condition, may so damage the head that late atrophy and flattening may develop. Additional fixation by means of a metal device probably is not often necessary.

The standard for an excellent result following bone grafting is much higher than that following use of other methods. An excellent result following such an operation consists of solid, bony union with practically full function of the hip. A good result is defined as a bony union with good function. A fair result as bony union with poor function. A poor result as no union. Results in the twenty-four cases in which extra-articular osteosynthesis was used are recorded in table 3.

SUMMARY AND CONCLUSIONS

1. The bone graft has been used in treatment of ununited fracture of the neck of the femur in ninety cases in the past thirty-two years at the Mayo Clinic. This number represents only about one in ten of patients admitted for the condition named. The relatively small group of patients treated by this method was carefully selected.

2. In the past twenty-five years the percentage of union obtained has been satisfactory and the functional results in those cases in which union has been obtained have been gratifying.

3. In the past ten years, extra-articular osteosynthesis, in which a fibular bone graft has been employed, has been adopted in the majority of cases. Use of this procedure is accompanied by very little shock; consequently, it has been possible to employ it in the treatment of a group of older patients than for-

TABLE 3

RESULTS IN THE TWENTY-FOUR CASES IN WHICH EXTRA-ARTICULAR OSTEOSYNTHESIS WAS EMPLOYED FOR NONUNION OF FRACTURE OF THE NECK OF THE FEMUR

Individual case numbers *	Total cases	Result
64, 67, 68, 69, 72, 73, 75, 80, 81, 83, 84, 86	12	Excellent
76, 77, 87, 88	4	Good
65	1	Fair
66, 71, 85	3	Poor
78, 82	2	Not traced
89, 90	2	Still under observation
Total	24	

* See tables 1 and 2.

merly was thought advisable, with no mortality and with good functional results.

RÉSUMÉ

La greffe osseuse dans le traitement des fractures non-unies du col du fémur fut dans les dernières trente-cinq années employée dans quatre-vingts-dix cas. Ce chiffre represente le dixième des cas admis pour cette condition un groups relativement petit et chosi avec soin. Le pourcentage des cas dans lesquels on a obtenu l'union est satisfaisant et les résultats fonctionnels furent heureux. Dans les dernières dix années, on adopté dans la majorité des cas la osteosynthèse extra-articulaire, employant une greffe prise sur le péronée. Ce precédé est accompagne de peu de choc. Conséquement chez les sujets âges, cette méthode n'a aucune mortalité et donne d'excellents résultats fonctionnels.

RESUMEN

En los pasados trienta y dos años se han empleado en la Clínica Mayo los injertos óseos en el tratamiento de noventa casos de fractura sin unión del cuallo del fémur. Esta cifra represanta sólo aproximadamente una décima parte del total de los pacientes admitidos en dicha institución con la referida lesión, es decir, un grupo relativamente pequeño y cuidadosamente seleccionado. El porcentaje de casos en los que se ha obtenido la unión ha sido satisfactorio con resultados funcionales altamente favorables. En los pasados diez años, se ha adoptado en la mayoría de los casos la osteosíntesis extra-articular empleando injertos óseos del peroné. El uso de éste método se acompaña de muy leve shock, siendo, por lo tanto, posible su aplicación en el tratamiento de un grupo de pacientes de mayor edad de la que antes se consideraba aconsejable sin que hubiera que lamentar ningún desenlace fatal y con la obtención de buenos resultados funcionales.

Свод

За последние 35 лет в Майо клинике костный трансплантат был применен в 90 случаях несросщагося перелома шейки бедра. Это число представляет собой сравнительно небольшую осторожно выбранную группу, составляющую около одной десятой всех таких переломов бедра, поступивших в клинику. Процент случаев, в которых было достигнуто сращение и хорошая функция, был очень удовлетворительный. В последние 10 лет обыкновенно употреблялся внесуставной остеосинтез при помощи малоберцового костного трансплантата. Это сопровождалось очень небольшим шоком и поэтому способ этот был применим без смертности и с хорошим функциональным результатом при лечении таких пожилых больных, к которым раньше этот способ считался не применимым.

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(Continued from page 25)

CONCLUSIONS

Most observers agree that the intertrochanteric osteotomy is as simple and shock proof a procedure as possible for the aged patient. It results in a marked increase in stability and lessening of the pain element in these disabling conditions of nonunion of the femoral neck. No complications were seen such as development of loss of angle, genu valgum or delayed union. Shortening was less than anticipated and ranged from 2.5 cm. to 3.8 cm.—easily made up by a simple shoe lift. Backache was decreased or eliminated, even in several cases with lumbar arthritis. The operation may be used even in old cases of nonunion. No walking splints or other apparatus except a shoe elevation is necessary.

RÉSUMÉ

L'ostéótomie inter-trochantérique est un procédé simple et à l'épreuve de tout choc chez les pèrsonnes d'un âge avancé. La stabilité est augementée et la douleur est diminuée. Aucune complication tels que perte de l'angle, genu valgum ou union rètardée ne s'est développée. Le raccourcissement est moindre qu'on n'anticipe est varia de 2.5 cm. à 3.8 cm. Le mal de dos est diminué ou éliminé même dans les cas compliqués d'arthrite lombaire. Cette opération peut être employée dans les cas de non-union. Aucun appareil excepté une élévation de la chaussures n'est nécessaire.

RESUMEN

La osteotomía inter-trocantérica constituye, dentro de lo posible, el procedimiento más simple y mejor cuando se trata de pacientes encianos con fractura del fémur sin unión. Con este método se aumenta marcadamente la estabilidad y se disminuye el dolor. Por otra parte, no se presentan complicaciones tales como pérdida del ángulo, genu valgum o retardo de la unión. El acortamiento de la extremidad puede ser menor que el previamente calculado. El dolor lumbar es disminuido o eliminado por completo incluso en los casos con artritis lumbar. El método descrito puede se empleado hasta en los casos antiguos de falta de unión. No es necesario aparato ortopédico sino un simple zapato con alza.

Свод

Для пожилых больных междувертлужная остеотомия является более простой и наименее шок причиняющей операцией. Она увеличивает стабилизацию и уменьшает боль. Осложнения, как потеря угла, genu valgum или позднее сращение, не развивались. Спинная боль уменьшалась или совсем прекращалась даже в случаях поясничного артрита. Эта операция применима даже в старых случаях несращения. Помимо под'ема башмака никакой аппаратуры не нужно.

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Late Complications in Fracture of the Neck of the Femur Treated by Nailing, Bone Grafting or Both

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THE irreparable loss of Fred H. Albee, master orthopedic surgeon, who was both my teacher and my friend, calls for a sincere tribute to his memory. This paper is presented as a very small contribution to achievements due to his concepts on the biological treatment of fractures of the neck of the femur.

Thirty years devoted to seeking the solution to the outstanding problem involved in the treatment of fractures of the neck of the femur, using different methods, each considered the best offered at the time of its application, has brought the firm conviction that anatomic, physiologic and pathologic factors coadjuvate to make the prognosis for union and functional rehabilitation very doubtful in this type of injury.

To ignore and disregard the aforementioned factors, and to consider every fracture of the neck of the femur as being susceptible to the same type of treatment, is an error often leading to poor results or even to complete failure. For this reason, when faced by the need for dealing with this type of fracture, we analyze each case from the three viewpoints already mentioned in order to select the proper method of treatment which should be followed in that particular instance.

These factors are briefly summarized as follows:

Anatomical factors.—Angles of inclination and declination of the neck of the femur must be restored to normal by a proper reduction of the fracture. The level of the fracture, as well as the amount of displacement of the fragments, and rotation of the head, has, as Albee very well brought out and emphasized, a great bearing on the amount of circulatory disturbance to be found in the head. Subcapital fractures with extreme varus and external rotation of the neck are difficult to reduce, as well as to maintain in the position of reduction, and show the greatest tendency toward rapid circulatory disturbances in the head, with more or less increased density at roentgenographic examination, and possible late fragmentation. Fractures with oblique lines are difficult to reduce and to maintain in alignment, showing great tendency to

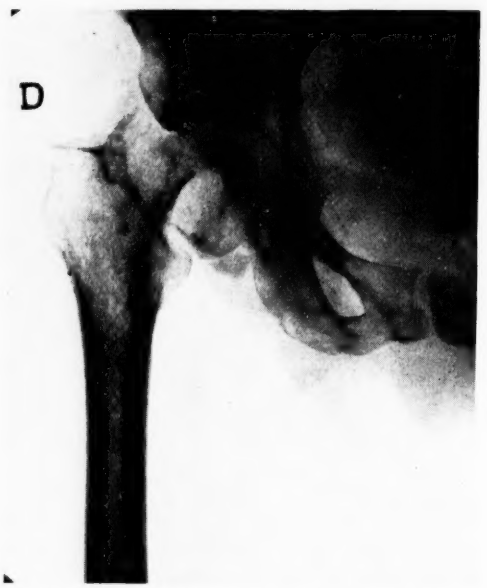


Fig. 1.—Fracture of the neck of the femur showing rapid absorption of the neck before reduction.

anterior bowing of the neck and coxa vara. Incomplete or well impacted fractures with slight valgus of the head, have the best prognosis and present the least difficulties in their treatment. Fractures located in the outer portion of the neck show a higher percentage of union than those located in the central portion, but both are considered as having a better prognosis than those situated close to the head. This fact is of great importance when attempting to draw conclusions as to percentages of union from statistical data.

Fig. 2.—Late fragmentation and aseptic necrosis of the head, with advanced hip ankylosis occurring after union had been obtained.

Physiological factors.—These are produced chiefly by circulatory disturbances in the head, as well as friction at the fracture site, and give rise to ischemia and condensation of the head, and to hyperemia and rarefaction of the neck. These changes are of great importance, and it has been our experience that they can be detected very early in the roentgenographic examination, which reveals reabsorption of the neck later resulting in shortening of this structure and nonunion.

Osteoporotic changes due to advanced age also influence the physiology of bone repair. These consist of large lacunae of the osseous trabeculae when seen roentgenographically. However, we have seen solid and undelayed union occur in patients at very advanced ages, proving that age *per se* is not the only factor responsible for osteoporosis but that this is due rather to associated metabolic and circulatory disturbances. Abnormalities in calcium and phosphorus metabolism and changes in the phosphate level, often throw light on the dissimilar clinical courses of fractures which are similar in type and have been subjected to the same treatment.

Pathologic factors.—In our series of cases we have found that untreated syphilis, pregnancy, and infectious diseases have influenced the prognosis of these fractures.

The preëxistence of some local pathological condition, such as Paget's disease, bone cyst, osteitis fibrosa, giant cell tumor, or malignancy, certainly influences the outcome of this fracture, and in our experience have been factors leading to delayed union or nonunion.

Neurotrophic changes are of importance due to the fact that the bone atrophy characteristic of them slows or prevents union. On two occasions we have seen fractures of the atrophic neck of the femur in poliomyelitis patients; in one of these, an eleven year old child, there had occurred a complete reabsorption of the neck of the femur, leaving a hip suitable only for a reconstruction operation.

In reviewing a fairly large number of cases of fracture of the femoral neck,

located proximally to the trochanteric region, we have further become convinced of the necessity of attempting to control as far as possible, every one of the factors mentioned if we are to expect a higher percentage of union and functional reintegration in hip fractures.

Complete correction of the anatomical alterations present in a fractured neck of the femur can only be accomplished through perfect reduction and maintenance of this reduction until fixation of the fragments has been carried out.

Leadbetter's maneuver for the reduction of this fracture has been very successful in our experience, provided that the fragments are entirely free from impaction, and that the line of fracture is more or less transverse in direction. In cases presenting slight impaction, this must be broken before attempting

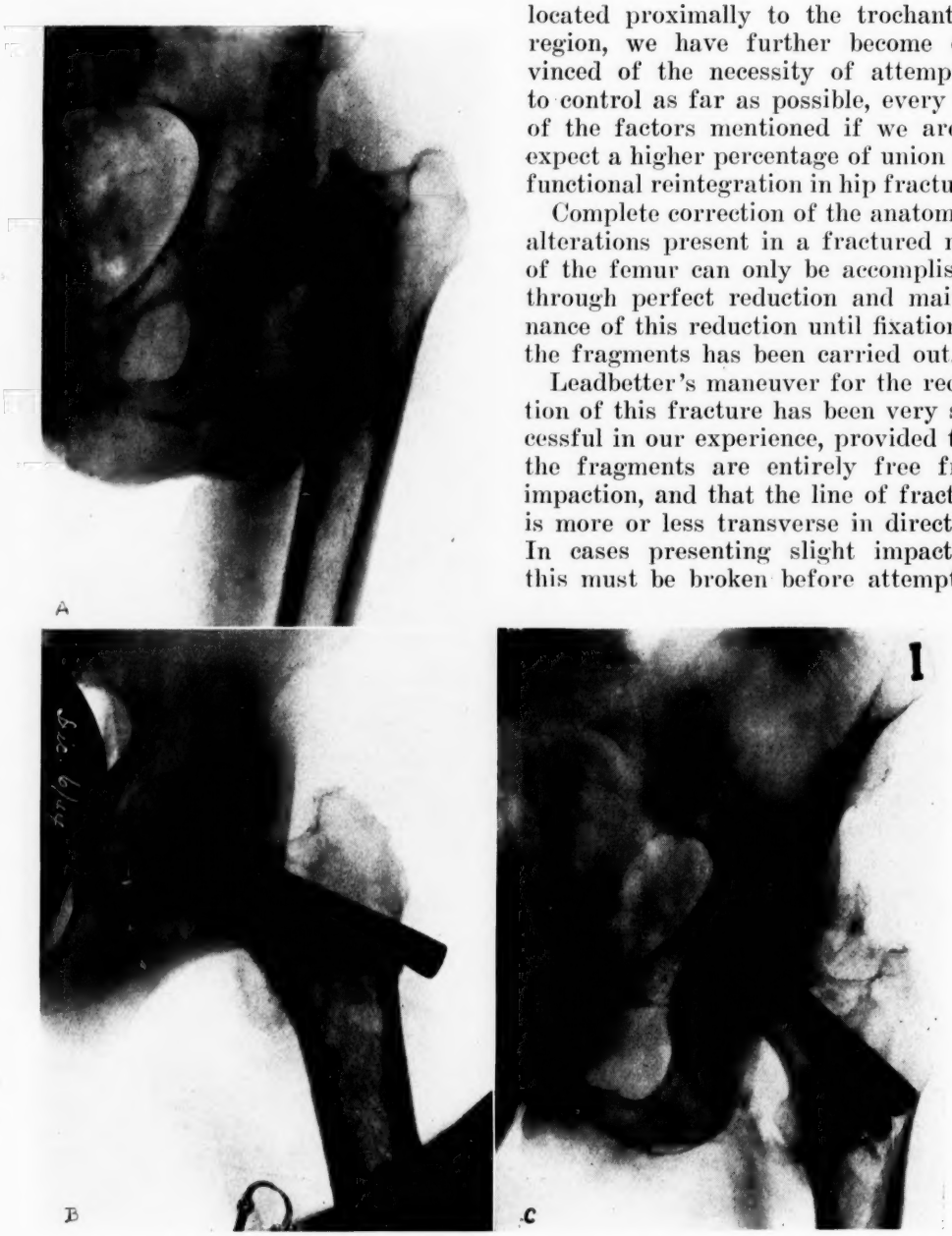


Fig. 3.—*A* Subcapital fracture. *B* Treated by bone graft and nail. *C* Protrusion of nail and marked bone formation around the joint. Final report upon union not obtained.

to carry out the reduction. If the line of fracture is oblique in one or two directions, reduction may be obtained, but traction, abduction, and internal rotation of the extremity must be employed to maintain it until internal fixation is carried out. The "heel test" described by Leadbetter will fail in these cases, and the reduction obtained will be lost if we attempt to carry it out. In order to obviate the tendency to loss of reduction which these oblique fractures have during the process of nailing, we have made it a practice to fix the fragments in position temporarily by means of two Kirschner wires passed through the neck and into the head, until the actual nailing has been accomplished, when they are removed. This very effectively prevents slipping of the fragments while the nail is being inserted.

Roentgenographs in both the anteroposterior and lateral planes are indispensable before attempting any type of extra-articular osteosynthetic procedure. To avoid unnecessary delay in developing and fixing the negatives, the use of warm solutions is recommended. If it is possible to use two portable roentgen-ray units, time will be saved, and roentgenographic control of the operative procedure will be greatly facilitated.

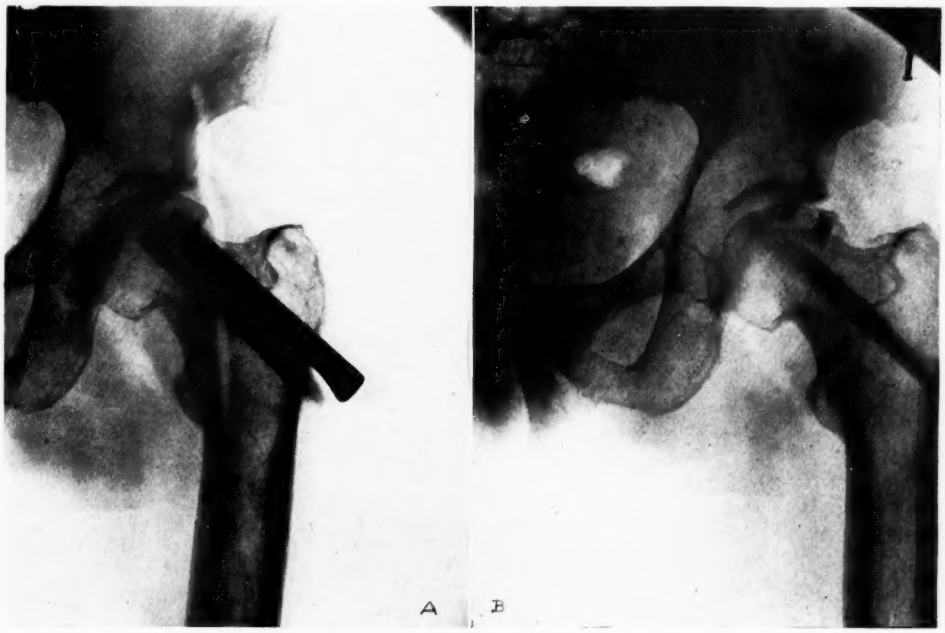


Fig. 4.—*A* Bone graft and nail with union. *B* A month later, partial necrotic changes similar to osteochondritis dissecans. Nail removed. Drilling.

Intra-articular anesthesia using 2 per cent procaine solution, has been our procedure of choice in all types of fracture of the femoral neck, for accomplishing the reduction. Operative procedures have been carried out in the majority of our patients through the use of regional anesthesia at the level of the greater trochanter by infiltrating with 1 per cent procaine hydrochloride. We believe that the type of anesthesia

used has a great bearing on the outcome of surgical procedures in the treatment of these fractures, and that the absence of operative mortality in our own series of cases is due largely to the use of the method of anesthesia described.

We have reviewed 134 cases of medial fractures of the neck of the femur, attempting to determine the complications which have followed surgical treatment, whether this has consisted of nailing or bone grafting or both. We have also included a number of patients who have come to us for treatment of delayed union, nonunion and other complications, following operative treatment carried out elsewhere.

Of these cases, 123 were white, 3 were mulattos, and 4 were negroes, the race being unknown in 4 cases. A striking feature has been the frequency of this

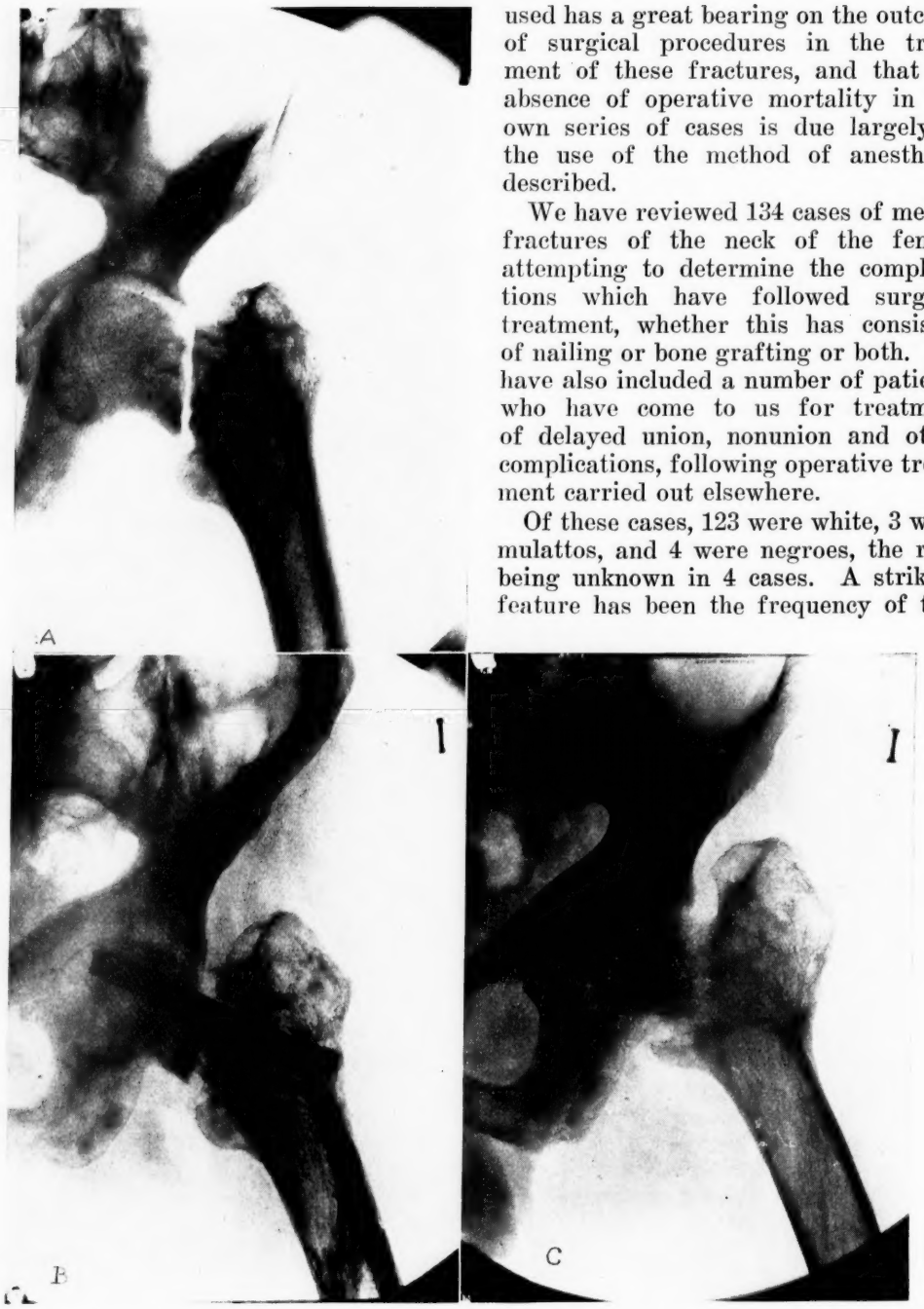


Fig. 5.—*A* Pathological transcervical fracture in Paget's disease. *B* Nailing. Nonunion. *C* Subtrochanteric osteotomy. Union.

fracture in the white, and its rarity in the negro race.

In reviewing the 24 cases which came to us with nonunion, we have been able to determine the type of treatment utilized in eight cases, as follows: two were treated with plaster spica; three with continuous traction; two with Godoy Moreira's screw; one, no treatment was employed.

AGE.—

Age	No. of Cases	Age	No. of Cases
11 years	1	39 years	1
19 years	1	40–49	13
22 years	1	50–59	23
28 years	1	60–69	27
29 years	1	70–79	33
30 years	1	80–89	23
31 years	1	90–100	4
36 years	3		

SEX.—

Number of patients	134
Males	59
Females	75

SIDE.—

Right hip	56
Left hip	78

Anesthesia Employed.

Spinal	20
General	5
Local and intra-articular	108

Site of Fracture in Recent Cases.

Subcapital	25
Transcervical	63
Cervicotrochanteric	18
Unrecorded	4
Ununited fractures treated	24

METHODS OF TREATMENT EMPLOYED.—

Recent Fractures.

Nailing (Smith-Petersen)	57
Bone graft (Albee)	2
Bone graft (Albee) and nail (Smith-Petersen)	7
Bone graft and nail (Sosa)	4
Conservative treatment (basal fractures)	
Skeletal traction	12
Plaster spica	2

Delayed Treatment.

Nailing (Smith-Petersen)	4
Bone graft (Albee)	4
Bone graft (Albee) and nailing (Smith-Petersen)	10
Total	18

Fractures with Neck Absorption.

Nailing (Smith-Petersen)	2
Bone graft (Albee)	0
Bone graft (Albee) and nailing (Smith-Petersen)	3
Total	5

Fractures with Nonunion.

Nailing (Smith-Petersen)	1
Bone graft (Albee)	3
Bone graft (Albee) and nailing (Smith-Petersen)	11
Double bone graft and nailing	1
Subtrochanteric osteotomy	3
Reconstruction of the hip (Albee)	4
Not treated	1
Total	24

We come now to the consideration of the specific late complications observed in our own cases, in an attempt to determine the causes which we believe led to them. We shall later present in detail those cases which we believe are of greatest interest. Conclusions are drawn from cases which have been followed for more than a year after operation. In subcapital fractures of the neck treated by the Smith-Petersen nail we have obtained union in 81.8 per cent of cases.

Late complications observed were the following:

Nonunion occurred in two cases. One of these patients was operated upon in 1937, utilizing Böhler's stainless steel nail. An unmodifiable 4-plus serologic reaction for syphilis was present. Absorption of the neck and complete disintegration of the head occurred. Final

RESULTS OBTAINED IN RECENT FRACTURES ACCORDING TO THE SITE OF FRACTURE AND PROCEDURE EMPLOYED IN THEIR TREATMENT.—

SUBCAPITAL FRACTURES.

	No. of cases	Under treatment	Union	Non-union	Other complications
Smith-Petersen nail	13	2	9	2	2
Bone graft	2	0	2	0	0
Bone graft and nail.....	8	0	7	0	2
Sosa's graft bearing nail..	1	0	0	1	0
Not treated	1	..	..	..	..
Total	25	2	18	3	4

TRANSCERVICAL FRACTURES.

	No. of cases	Under treatment	Union	Non-union	Other complications
Smith-Petersen nail	43	11	31	1	4
Bone graft	4	0	4	0	0
Bone graft and nail.....	9	2	7	0	0
Sosa's graft and nail.....	3	0	3	0	0
Total	59	13	45	1	4

CERVICOTROCHANTERIC FRACTURES.

	No. of cases	Under treatment	Union	Non-union	Other complications
Smith-Petersen nail	4	0	4	0	0
Bone graft	0	0	0	0	0
Bone graft and nail.....	0	0	0	0	0
Sosa's graft and nail.....	0	0	0	0	0
Conservative	14	0	14	0	3
Total	18	0	18	0	3

treatment consisted of subtrochanteric osteotomy followed by union and good functional result. The second case was treated by a Smith-Petersen stainless steel nail in November 1939. Hypertension and generalized arteriosclerosis were present. In January 1940, a shorter vitallium nail was substituted, and an autogenous bone graft preserved under refrigeration in citrated blood was inserted parallel to it. The patient left the hospital on October 6, 1940 with union, but died four months later of cerebral hemorrhage.

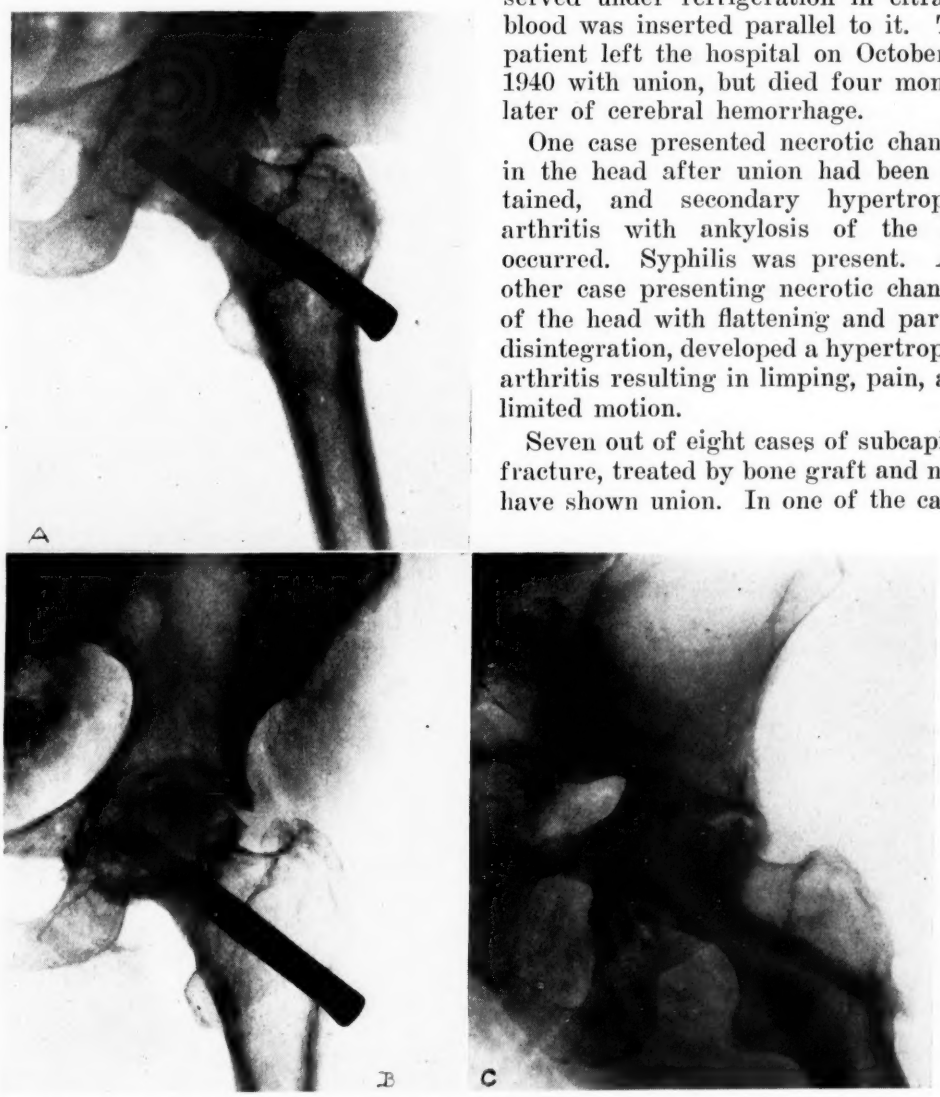


Fig. 6.—*A* Transcervical fracture treated by Smith-Peterson nail. Union. *B* Necrotic disintegration of head. *C* Bone graft and drilling. Osteoarthritis.

One case presented necrotic changes in the head after union had been obtained, and secondary hypertrophic arthritis with ankylosis of the hip occurred. Syphilis was present. Another case presenting necrotic changes of the head with flattening and partial disintegration, developed a hypertrophic arthritis resulting in limping, pain, and limited motion.

Seven out of eight cases of subcapital fracture, treated by bone graft and nail, have shown union. In one of the cases included in the record as a late complication, final data about definite union were not obtained. Late complications

were seen in only two patients. A 94 year old syphilitic woman with loss of sphincter control and senile psychosis was treated by means of an homologous bone graft taken from a donor of the same blood group, and a Smith-Petersen nail. Postoperative immobilization in this patient was impossible. The femoral neck showed rapid absorption, and marked periarticular ossification was observed. The nail protruded into the joint cavity. This patient left the hospital, and the final result could not be observed. Another patient, after union was obtained, developed localized necrotic changes in the head, occurring at the tip of the nail, and similar in appearance to those seen in osteochondritis dissecans. These were noticed more than a year after union had been obtained. The nail was withdrawn, and several drill holes were made through the area of sclerosis in an effort to create new circulatory channels to irrigate the necrotic area. This failed, and the patient finally developed deformity of the head and hypertrophic arthritis of the hip. Recently he has been seen presenting clinical signs of paralysis agitans. He can walk without a limp but hip motion is limited.

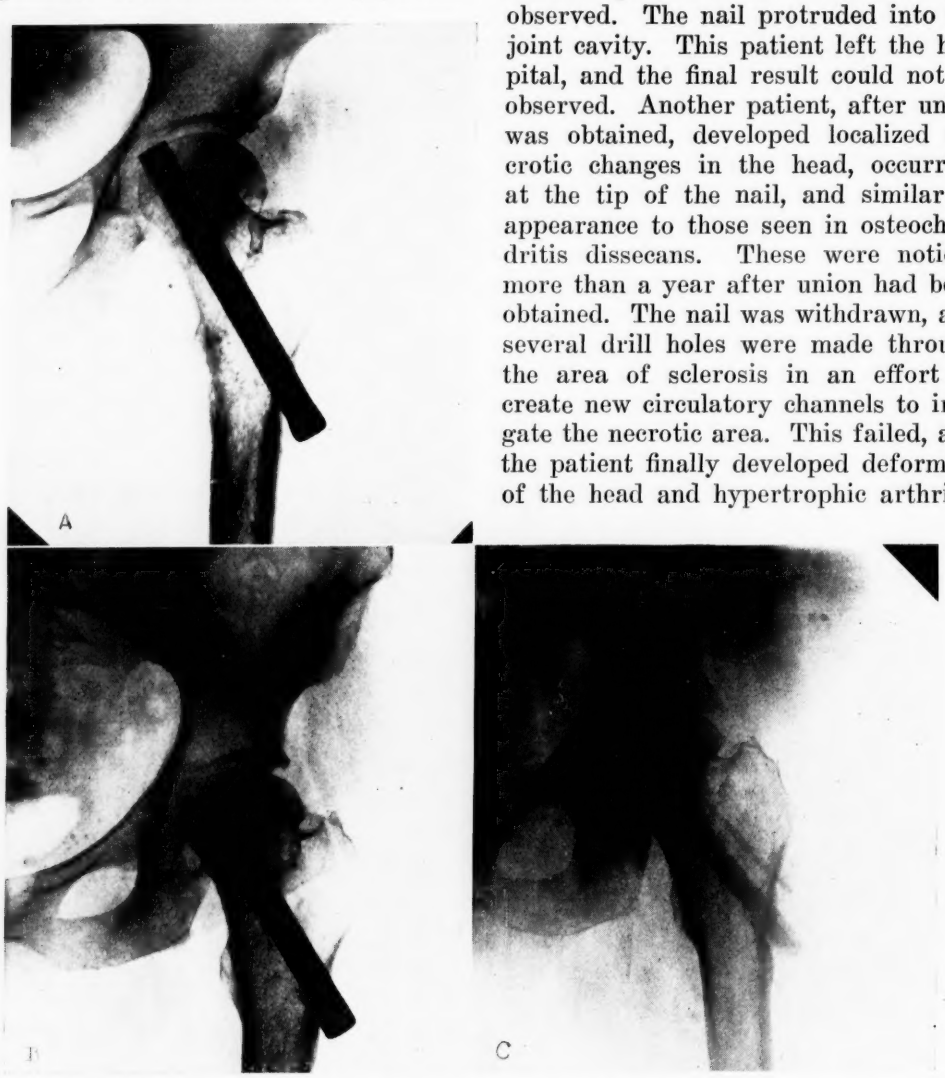
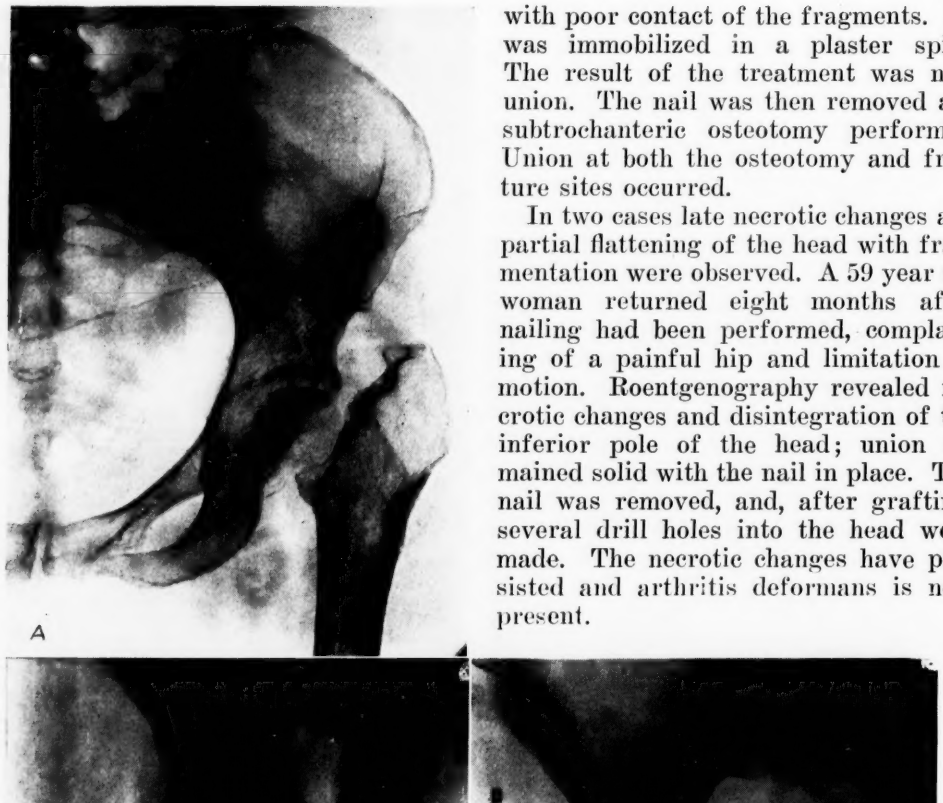


Fig. 7.—*A* Long protruding nail. Union. Nail changed. *B* Late necrotic head with marked condensation and flattening. *C* Bone grafts and drilling as treatment. Osteoarthritis.

The only case of subcapital fracture treated by Sosa's graft bearing nail resulted in nonunion. The nail was withdrawn and replaced by a Smith-Petersen nail and an autogenous refrigerated bone graft. This resulted in union with shortening of the neck and some limitation of abduction and external rotation.

Transcervical fractures treated by Smith-Petersen nail resulted in union in 96.8 per cent of cases. One case of nonunion was found. A man 45 years old presented a pathological fracture of the neck of the left femur in which marked changes due to Paget's disease were present. The opposite hip was ankylosed due to childhood tuberculous coxitis, and the femur on that side showed great atrophy and shortening. He was treated by Smith-Petersen nail after a reduction, which was only fair

Fig. 8.—Roentgenogram of subcapital fracture of the neck of the femur. Typhoid fever with secondary osteomyelitis and marked destruction.



with poor contact of the fragments. He was immobilized in a plaster spica. The result of the treatment was nonunion. The nail was then removed and subtrochanteric osteotomy performed. Union at both the osteotomy and fracture sites occurred.

In two cases late necrotic changes and partial flattening of the head with fragmentation were observed. A 59 year old woman returned eight months after nailing had been performed, complaining of a painful hip and limitation of motion. Roentgenography revealed necrotic changes and disintegration of the inferior pole of the head; union remained solid with the nail in place. The nail was removed, and, after grafting, several drill holes into the head were made. The necrotic changes have persisted and arthritis deformans is now present.

Fig. 9.—*A* Ununited fracture with great absorption of the neck. *B* and *C*, treated by bridging with refrigerated bone graft and nail.

The second case was that of a 54 year old woman who had been treated by Smith-Petersen nail in Miami, Florida, in August 1943. The nail was long, protruding into the joint cavity, and the patient complained of pain on weight bearing. On December 17, 1943, we substituted a shorter nail, union being of these. Weight bearing was forbidden, passive and active movements with the aid of pulleys being instituted early. On August 3, 1945, her roentgenographs showed slight improvement in the sclerosis of the head. She is now allowed to walk with the aid of crutches and is symptom free.

Fig. 10.—Same patient as shown in fig. 9. Periodical roentgenograms up to four years after operation showing complete regeneration of neck of femur, clinical evidence of the bone-forming capacity of bone grafts.

already present. She was discharged symptomless in February 1944, leaving Havana at that time. She returned on April 30, 1945, sixteen months after her operation, complaining of pain on weight bearing, limping, and limitation of motion which had been present for three months. Roentgenographs showed marked necrotic changes and flattening of the femoral head and slight osteoarthritic changes of the hip joint. On June 5, 1945, the nail was removed and an autogenous bone graft was inserted. Small drill holes were made into the head and thin grafts were placed in two

A 59 year old woman left the hospital while still under treatment due to the onset of typhoid fever, and was lost track of temporarily. She returned with pain, redness, and swelling in the operative site, roentgenographs showing osteomyelitis of the neck. The nail was removed; this being followed by complete destruction of the neck and sequestration of the head.

None of the cases of transcervical fracture treated by both grafting and nailing showed late complications. There has been no operative or immediate postoperative mortality. One

patient died four weeks following operation, of bronchopneumonia. Two patients have died within a year following operation, one eight and one nine months later, of pneumonia and cerebral hemorrhage respectively.

After reviewing our cases, we must again consider the oft-discussed and much debated question of the role played by the bone graft in solving the problems presented by this type of fracture, such as union, reëstablishment of circulation to the head of the femur, and the prevention of late necrosis and deformity of the head, which lead to chronic arthritis and fibrous ankylosis. In three of our cases of almost total absorption of the neck, grafts placed bridging the gap, lying within the joint, with their proximal ends located in a necrotic head, and therefore situated under extremely poor conditions from the standpoint of nutritional requirements, have been capable of restoring the normal contour and structure of the neck. These cases have been carefully followed by serial roentgenographs which have shown the ability of the graft to produce a new neck in place of the absent one. We believe that these clinical findings speak clearly in support of Dr. Albee's contention that a properly placed graft retains its vitality. For this reason we believe sincerely that the early use of a bone graft in the treatment of fractures of the neck of the femur is to be emphatically recommended if we are to avoid many or all of the late complications observed in cases treated by nails, screws, bolts, and other mechanical devices used for obtaining internal fixation. Sclerosis of the neck and ischemia of the head are physiological problems incapable of solution solely by the application of mechanical fixation, which maintains reduction, but cannot fulfill the biological requirements of fractures presenting those alterations of normal bone physiology. This view is borne out by the study of our own patients, which indicates that in a large series of cases, the use of bone grafts has resulted in a greatly lowered incidence of late complications.

As to mechanical fixation of the fracture, we believe that the Smith-Petersen nail best fills the necessary requirements. Among its advantages over other methods of internal fixation, are the fact that it causes less trauma, is easier to place, and that it will prevent interrotation of the fragments. The latter gives rise to absorption at the fracture site, and is a decided disadvantage presented by various screws which have been devised to maintain reduction in this type of fracture. When properly selected and well placed, the Smith-Petersen nail will hold the penetration of the fragments obtained by the use of the impactor during the nailing procedure, and in case shortening of the neck occurs, it has a tendency to slide out without producing disjunction of the fragments.

In subcapital fractures of the neck of the femur, and in every case in which the weekly roentgenographic examination shows a tendency toward increased density of the head, or absorption at the fracture site, a bone graft must be used, and cannot be too strongly recommended, to solve the biological problems involved. In order to reduce operative shock, we have been using, for the past five years, refrigerated bone grafts, taken from the patient or from a donor. Our experiences with this method of grafting were presented at the Academy meeting in New Orleans, January 15, 1941, and were published in the Journal of Bone and Joint Surgery for January, 1942.

We have observed a difference in end results between cases treated by nailing, and those in which grafts have been used, either alone or associated with the Smith-Petersen nail used to obtain fixation. Even in the latter type of case we have seen, on occasion, the production of necrotic changes of the head in close proximity to the nail. However, we do not believe the nail to be responsible for such changes, since we have often seen the same occur in cases which had been treated conservatively, after perfect union had been obtained.

Our statistics show that 47 cases of fractures of the neck of the femur treated only by nailing with the Smith-Petersen nail, and followed for more than a year, have shown nonunion in three instances, and late complications such as necrosis of the femoral head, disintegration, flattening, arthritis deformans, or ankylosis have occurred in six more patients, giving an incidence of 19.1 per cent of complications for the series. In twenty-one cases treated by graft alone, or graft and Smith-Petersen nail, and followed also for more than a year, we have observed nonunion in one case, and partial necrosis of a cephalic pole in another, giving 9.5 per cent of late complications for this second series. This speaks in favor of the use of the latter type of treatment, especially since the second series consisted of cases which frequently were seen after considerable delay, already showing early absorption of the neck, or were subcapital fractures in which the viability of the head was doubtful.

CONCLUSIONS

Late complications of fractures of the neck of the femur are due to poor reduction, deficient maintenance of a previously good reduction at the time of or after fixation, improper fixation of the fragments, infections and circulatory disturbances which lead to neck absorption, delayed union, nonunion and necrotic changes in the head of the femur.

A proper selection of the type of treatment is indispensable in order to avoid such complications. This selection should be carried out after proper consideration and evaluation of the various anatomical, physiological, and pathological factors found to be operative in each individual case.

Bone graft associated with internal fixation by means of the triple flanged Smith-Petersen nail should be used in all cases presenting subcapital location of the fracture and early circulatory changes in the neck, which demand restoration of the impaired local biologic status at the site of fracture.

Undeniable clinical and roentgenographic evidence is presented to demonstrate the viability and bone forming or rebuilding capacity of bone grafts when used in the treatment of recent and old fractures of the neck of the femur.

RÉSUMÉ

Les complications tardives des fractures du col du fémur sont dues à une mauvaise réduction, à un maintien défecteux d'une bonne réduction au moment de la fixation ou après la fixation à une fixation fautive des fragments, à l'infection, et à un dérangement circulatoire aboutissant à l'absorption du col, à une union retardée, à une non-union et à une nécrose de la tête du fémur. Il faut choisir le traitement qui prévient ces complications. Cela demande la considération et l'évaluation de tous les facteurs présents dans chaque cas. Dans tous

les cas de fractures sous-capitales associées avec dérangement circulatoire dans le col, on emploiera la greffe osseuse avec fixation au moyen du clou Smith-Petersen. Ces fractures demandent une restoration biologique locale. L'auteur présente des preuves conclusives cliniques et roentgénographiques de la viabilité des greffes osseuses, employées dans les fractures du col du fémur récentes et anciennes.

RESUMEN

Las complicaciones tardías de las fractures del cuello femoral son debidas a reducción deficiente, a falta de sostenimiento de una previa reducción adecuada ya sea en el momento de la fijación o después de ésta, a la fijación impropria de los fragmentos, a las infecciones, a transtornos circulatorios, a unión retardada, a falta de unión y finalmente a alteraciones necróticas en la cabeza del fémur.

Es indispensable la elección apropiada del tipo de terapéutica a emplear a fin de eludir las complicaciones referidas. La selección de la terapéutica debe realizarse después de estudiar y de determinar el justo valor de cada uno de los factores operatorios en todos los casos.

El injerto óseo asociado a la fijación interna mediante el clavo de Smith-Petersen constituye el método de elección en los casos de fractura subcapital con alteraciones circulatorias precoces del cuello, lo cual require la restauración del estatus biológico in situ.

En éste artículo se presentan pruebas radiológicas y clínicas que demuestran la viabilidad del procedimiento y la capacidad de regeneración y formación ósea de los injertos óseos cuando se emplean tanto en las fracturas recientes como en las antiguas, localizadas en el cuello femoral.

Свод

Поздние осложнения при переломах шейки бедра причиняются: плохой редукцией; недостаточным сохранением хорошей редукции во время или после фиксации; неправильной фиксацией фрагментов; инфекцией; расстройствами кровообращения, ведущими к абсорпции шейки, позднему сращению, несращению и некрознему процессу в головке бедра.

Чтобы избежать эти осложнения безусловно необходим правильный выбор способа лечения. Этот выбор должен быть сделан на основании правильной оценки всех активных факторов в каждом отдельном случае.

Костный трансплантат с внутренней фиксацией при помощи гвоздя Smith-Petersen'a должен быть применен во всех случаях субголовочного перелома с ранними переменами в кровообращении шейки, так как они требуют немедленного восстановления нормальных биологических отношений у места перелома.

Приведены убедительные клинические и рентгенографические доказательства жизнеспособности костных трансплантатов и их способность не только образовать новую кость, но даже перестроить ее как в недавних, так и в старых переломах шейки бедра.

ERB'S PARALYSIS

"Erb's paralysis is due to an injury of the fifth and sixth cervical nerves, and usually occurs in babies after a difficult labor. The arm is held in the characteristic 'policeman's tip' position."

(From "*Physical Signs in Clinical Surgery*" by Hamilton Bailey. Bristol, England: John Wright & Sons, Ltd., 1944.)

Arthroplasty for Congenital Dislocation of the Hip

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FIFTEEN years ago I used the arthroplastic procedure described below on a child of six, for congenital dislocation of the hip. Several follow-up papers have since been published, demonstrating the permanency of this method in late follow-up studies.[1, 2, 3]

Congenital dislocation of the hip is an interesting phenomenon. The educational propaganda stressed by Putti and others, of carefully examining the hips of new born babies and instructing parents in the early clinical signs, has resulted in frequently recognizing and instituting treatment within the first six months of life. In spite of this, the majority of cases are probably not recognized until the child begins weight bearing.

In the first few years of life, a great proportion of cases can be effectively reduced and the reduction retained by closed methods of treatment. However, in approximately 25 per cent of the unilateral cases with congenital dislocation of the hip and 35 to 40 per cent of the bilateral cases, the head will not be retained in the acetabulum. If weight bearing is allowed to these patients, the clinical signs of instability and shortening will become manifest. Statistics representing the percentage of failure in children will be increased if closed reduction is attempted in a child over five.[4] There will also be a higher percentage of serious injuries, for not only will excessive stretching of the soft parts result in fibrosis of the periarticular tissues of the hip, but too vigorous maneuvers may also cause the development of an aseptic necrosis of the head of the femur.

Those with experience in performing some type of osteoplastic buttress, or shelf operation, have found in their follow-up studies, that if this procedure is done at too early an age there is a great tendency for the shelf or buttress to melt away under the constant stresses and strains of childhood activity. Many orthopedic surgeons do not recommend the shelf operation until the child has reached eight to ten years of age.

The author's personal experience coincides with the above view. He has felt for some years that the arthroplastic operation described, is therefore most applicable for two classes of patients having a congenital dislocation of the hip.

The first class includes young children under three or four, who, in spite of careful manipulative reduction and retention in plaster, have suffered recurrence. It is felt that the fundamental cause for redislocation, is a shallow, poorly formed acetabulum. A certain number of these failures are also probably caused by the redundancy of the capsule, its folds separating the head from its normal position in the acetabulum. It may also be due to increased anteversion of the neck, as has been demonstrated by Krida.[5, 6] He and others have demonstrated that internal rotation of the hip a few weeks after reduction has been primarily achieved, will permit the head to be more deeply placed within the acetabulum, and thereby lessen the opportunity for redislocation. There may be other factors

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that render some of these hips susceptible to redislocation.

The second class comprises those slightly older patients who have not received any treatment, or, at best, inadequate treatment.

ARTHROPLASTY OPERATION

Technique.—There have been no essential changes made in the method since originally published. The reduction treatment is divided into two stages. Stage one consists of demonstrating that the head of the femur can be pulled down opposite to the level of the original acetabulum. Whether this be done manually, as demonstrated by a push-pull x-ray or whether a preliminary period of skin or skeletal traction to the affected extremity be required while immobilizing the opposite side in a plaster spica, can be determined for the individual case. Complete relaxation of the soft tissues must be obtained before the child is considered ready for the second stage. In some of the older cases it has been found useful thoroughly to stretch the hip by the maneuvers of straight leg raising and abduction, with or without subcutaneous adductor tenotomy, preliminary to applying moleskin or skeletal traction. The degree of telescoping or laxity varies considerably and is not altogether dependent on age, although largely so. If, however, the head is not brought at least opposite the original acetabulum before the second stage or open operation is done, too much tension and too much force must be used at the open operation to reduce the head. This will give rise to impairment of joint function and expose the child to the development of aseptic necrosis of the epiphysis or to traumatic arthritis of the joint.

The second stage consists of exposing the hip joint by the lateral approach, extending the incision from just behind and parallel to the anterior superior spine of the ilium, curving downward and crossing the shaft of the femur several inches below the tip of the greater trochanter. After dividing the fascia and retracting the tensor fascia femoris muscle medially, the muscles attached to the greater trochanter come into view. The tip of the greater trochanter, to which are attached the abductor muscles, is cut through and the capsule easily separated by scissors dissection from the overlying group of muscles. The isthmus or hour-glass contraction of the capsule can then be identified. The capsule is divided at its narrowest point; then, by externally rotating the shaft of the femur, the capsular-covered head of the femur can be separated from the muscles posterior to the capsule. The capsule is then closed at the cut isthmus area by several interrupted catgut sutures and the remaining or proximal portion of the capsule about the rim of the old acetabulum is removed as completely as possible. Holding the limb externally rotated and sharply adducted, the site of the original acetabulum can be easily identified, inspected and palpated. With a large curette or Doyen reamer, a capacious acetabulum is then reamed out at the level of the original acetabulum. This point is most easily recognized by identifying the triradiate cartilage which makes up the floor of the normal acetabulum. It should be pointed out that a remarkably deep acetabulum can be obtained. At this level, the innomimate bone is very thick and when this procedure is done for the first time, the operator is always surprised at the amount of bone that may safely be removed from this site. If the case is a unilateral dislocation, the site of the acetabulum can also be

roughly judged by estimating the level of the tip of the greater trochanter or anterior superior spine on the normal side. The newly made acetabulum must be large and deep with a good roof. Its floor must be smooth so that when the mated. The wound is then closed in layers. With the hip in complete extension, slight abduction and neutral position as regards rotation, a unilateral plaster spica is applied from the nipple line to the toes.

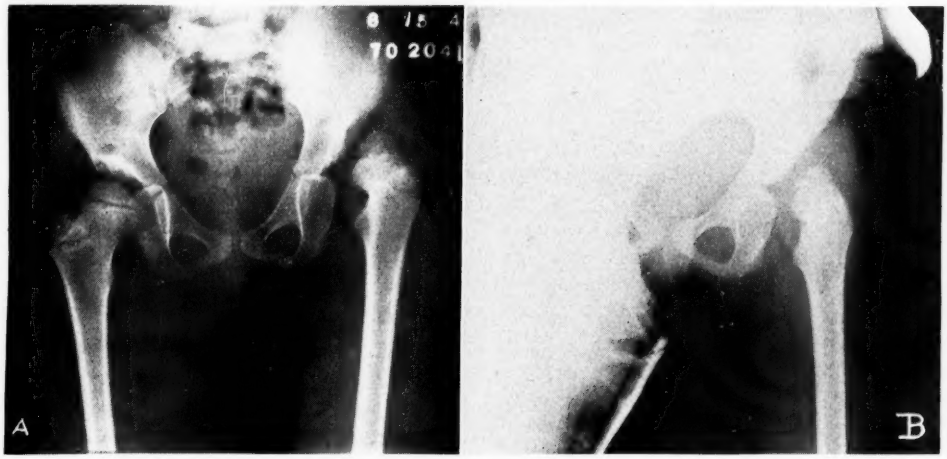

Fig. 1.—*Case 1.* *A* Girl, aged 5 years, preoperative roentgenogram. *B* At end of first stage; head of femur pulled down by skin traction and immobilization of opposite hip in plaster of paris spica.

curetting is finished, there is a domed and properly sloping superior roof made. With gentleness then, the capsular covered head is placed deeply within this newly made acetabulum, and the limb placed in about twenty degrees abduction. No effort is made to suture or to attach the capsule that covers the head when it is placed in the newly formed acetabulum. It is believed that the outer surface of this capsule becomes firmly glued to the raw bony walls of the newly formed socket. The greater trochanter with its attached muscles is resutured in position. It has not been found necessary to transfix the greater trochanter with any bone graft; rather a number of interrupted catgut sutures are applied in the soft cartilaginous tissues when the cut surfaces of the greater trochanter are snugly approxi-

POSTOPERATIVE CARE

After care.—This phase of the treatment is a very important one in the failure or success of any operation. Ordinarily we remove the patient from the plaster spica at the end of four weeks. However, the limb must be supported by balanced suspension in a molded posterior shell which extends from the groin to the toes. Active motion at the hip while the patient is recumbent is begun, training the patient particularly in the movements of active abduction. If a therapeutic pool is available this can be utilized about two weeks after this muscle re-education has been started. By the simple expedient of keeping a pillow between the legs we have kept the limb in some abduction while active motion is being instituted. At the slightest evidence of adductor

spasm or "stiffening up" of the joint (and this should be watched for by daily examination), traction is to be applied to the lower extremity and motion temporarily stopped. The re-adjustment of a hip joint reconstructed by arthroplasty must be considerable, and while young growing tissue is extremely plastic and susceptible to new conditions, it must be coddled a little and not pushed beyond its limits of endurance. Adductor muscle spasm is

Fig. 2.—Same patient as in fig. 1, about one year after second stage operation, showing deep socket at normal level following arthroplasty operation described. Full range of motion and no shortening.

one of the earliest signs of joint irritation, and joint irritation in this case means loss of abduction, which in turn means increased adduction. This position of the hip gives opportunity for redislocation.

If the patient is cooperative, he may safely be fitted with crutches about eight weeks after the second stage, but no weight bearing may be allowed under at least three months. Occasionally some of these reconstructed hips with limited motion have responded to gentle stretching under anesthesia and have developed increased movement. The patient's mother is always instructed to give daily stretching exercises at home, the value of complete extension and wide abduc-

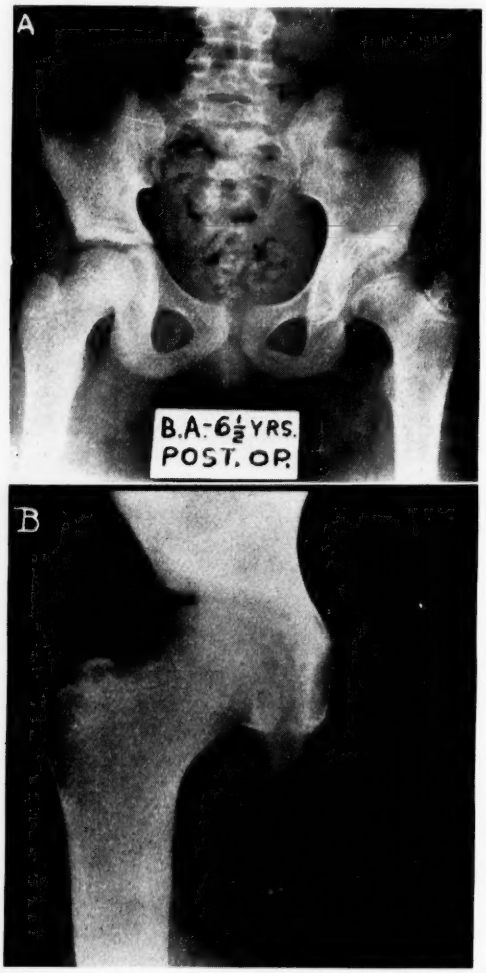

Fig. 3.—*A Case 2.* Unilateral congenital dislocation of hip corrected six and one-half years ago; normal range of motion with stable, painless hip; no shortening. *B Case 3.* Unilateral congenital dislocation of hip corrected eight years ago; normal range of motion with deep acetabulum and stable, painless hip; slight shortening due to coxa vara.

tion being stressed. One cannot emphasize too strongly that, at the first sign of joint irritation—whether this occurs early or late—weight bearing must be

interrupted. A few days of traction in bed will allow the painful hip to regain its motions. Weight bearing, under ideal conditions, should not begin earlier than three months. At times it should be delayed until six months.

One recent case is reported in detail and several follow-up roentgenograms of other cases, taken many years after operation, are shown (figs. 3 *A* and *B*).

CASE 1.—Girl, aged 5, first child, had been normally delivered and walked at the age of one year. She presented the characteristic painless limp with a positive Trendelenberg sign and one-half inch shortening. Roentgenogram (fig. 1 *A*) showed a typical high left congenital dislocation. From examination, there appeared to be increased anteversion.

She was admitted to the University of Pennsylvania Hospital on Sept. 18, 1944. Stretching of the left hip, with subcutaneous tenotomy of the adductors and application of a plaster of paris spica to the right side and ten pounds skin traction to the left leg, was instituted.

After a few weeks of traction, which comprised the first stage, the head was pulled down to the acetabulum as shown in fig. 1 *B*. The second stage, or open operation, was done on Oct. 11, 1945 following the procedure described. Due to the increased anteversion of the hip after reduction into the reconstructed acetabulum, it was placed in internal rotation.

On November 1, the plaster cast was changed and a supracondylar osteotomy was done and the distal fragment rotated externally until the patella was pointing upward. A plaster of paris spica was worn for the following several weeks. Then a cylinder plaster from the groin to the knee was applied and motion in bed begun by overhead swinging apparatus. This was continued until firm union at the site of the supracondylar osteotomy occurred. Then the plaster cast was completely removed and the patient discharged to her home, but walking with crutches and carefully cautioned against any weight bearing.

Follow-up Notes.—Jan. 12, 1945.—She has no complaints. She has about 10 degrees flexion contractures at the left hip. R.A. (distance, anterior superior spine to internal malleolus), 20½ inches (51.25 cm.); L.A., 20½ inches (51.25 cm.). She has a range of motion from about 170 degrees to 90 degrees. There is excellent range of abduction, active and passive. There is good rotation and the result seems very splendid. Cautioned against any weight bearing on left hip and to walk only with aid of crutches. Mother is instructed to stretch hip daily into full extension and abduction.

Jan. 29.—Patient has a range of motion from 170 to 80 degrees and practically normal abduction. She may be allowed to bear a little weight on her hip but with any evidence of pain or change in the motion, this is to be discontinued. New roentgenogram shows head extremely well placed. Return in two weeks.

Feb. 14.—Patient has a very good range of motion but there seems to be a little more restriction on abduction than previously. She was advised not to bear weight for the next month and to use crutches except for 20 steps a day in order to improve the motion in the hip. Return in one month.

March 14.—She has an excellent range of motion. There is flexion contracture. New roentgenogram is quite satisfactory. Right shoe—elevate heel and sole one inch.

April 27.—Results to date are excellent. Begin more weight bearing.

June 4.—Patient may discard crutches and engage in activities of all sorts except skipping and jumping. Her mother is to stretch the hip into the frog position daily. Return in three months for new roentgenogram.

Sept. 25.—Angle of greatest extension, 180 degrees; angle of greatest flexion, 60 degrees. Other motions excellent. New roentgenogram shown in fig. 2. Return in four months. Patient is very active. R.A. equals L.A. There is no limp noted.

SUMMARY

A brief summary is given of results with various modern procedures for re-

(Continued on page 61)

Replacement of Lower End of Femur or Upper End of Tibia

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REPLACEMENT of defects of the femur and tibia tax the effectiveness of bone grafting to its utmost, due to the mechanics of weight bearing.

Reports on successful bridging of major defects are scarce, due obviously to the fact that extensive resection of the femur is contemplated only for malignancies. In these cases, most surgeons prefer amputation or disarticulation. However, "the frequency of recurrency and metastases after a radical operation may be taken as proof that the final result of surgery depends on the biological character of the tumor rather than on the particular sort of intervention." This opinion was advanced in my report of two cases (1933) [1] in which part of the femur was resected for sarcoma. Albee [2] in a paper, "Treatment of primary malignant changes of bone by radical resection and bone graft replacement" (1936), mentions one case of tumor of the femur. Phemister,[3] reporting two cases of "rapid repair of defect of femur by massive bone grafts after resection for tumors" (1945), justifies the procedure applied by a "greater tendency toward resection of carefully selected cases of bone tumors, particularly slow growing sarcomas and borderline cases that are recognized early and are favorably located for resection."

In one of my cases, the tumor was located in the distal end of the femur. It was deemed advisable to apply a method, which was first practiced by Klapp [4] in the case of a tumor of the proximal end of the tibia. In 1921 Juvara,[5] independent of Klapp, employed the principle of this operation in a case of benign tumor of the distal end of the femur. Putti [6] and Lexer [7] performed similar operations. Another case was reported by me in 1936.[8]

The essentials of the method are schematically illustrated in fig. 1.

In tumors of the lower part of the femur, a resection of the lower third is performed. The upper part of the tibia is split in the midline and its medial half dissected to a length sufficient to allow replacement of the excised part of the femur and in addition permit secure anchorage to the femoral stump (fig. 2). For this purpose, the proximal end of the tibia is reversed and may be shaped like a clothes-pin, one branch being impacted into the medullary cavity while the other contacts the femoral cortex (fig. 3). It is unnecessary to apply screws or wires or other means of internal fixation.

In contrast with the usual tibia graft taken from the shaft, this method offers the advantage of reconstructing the knee joint. After the graft has been implanted, the remainder of the joint capsule and the stumps of the lateral and cruciate ligaments are united by silk sutures, as are the cut ends of the patella tendon. The patella is excised in toto.

In case 1, the upper end of the tibia was split from side to side utilizing the anterior half as a free graft. The resulting articulating surfaces were long

This paper is devoted to the memory of the late Fred H. Albee whose pioneer work has made possible massive bone grafts.

and narrow, which, from a mechanical point of view, was not suitable for a neärthrosis. The result was an almost

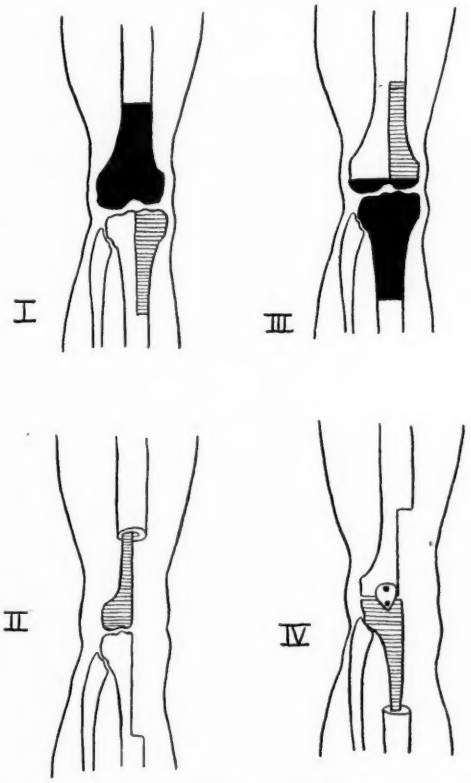

Fig. 1.—I and II, resection of lower end of femur—defect replaced by half of upper end of tibia with reconstruction of joint. III and IV, resection of upper end of tibia—defect replaced by half of lower end of the femur; patella serves as only graft.

complete ankylosis (fig. 4). A six year follow-up showed no recurrence or metastases. Incidentally, Campbell,[9] in "Operative Orthopedics," in describing this operation, recommends splitting of the tibia in the same way.

In case 2, splitting of the tibia was performed in an anteroposterior direction, utilizing the medial half as a graft (fig. 5). Here a sufficient range of motion was secured in the new joint. This must be regarded as a definite advantage although the patient had to wear a short brace with a knee hinge. He was last seen ten months after the operation, at which time his condition was satisfactory. Since then no report has been obtained.

The question whether or not to mobilize the knee joint in these cases is open to discussion. Grigorescu and Vasiliu,[10] who examined Juvara's case, are rather definite in rejecting the idea of a mobile joint. It is my opinion that the particular configuration of the articulating surface of the tibia invites

Fig. 2.—Lower femur, upper tibia and interior knee joint are exposed by Krida's utility incision (insert B). The lateral and cruciate ligaments are divided as is the patellar tendon. Lines of dissection of femur and tibia are marked.

the formation of a neärthrosis. If this should prove unsatisfactory, a fusion operation can still be done.

The circumstances are different in tumors of the upper end of the tibia. In applying the principle of the operation in these cases, no attempt should be made to perform an arthroplasty, in view of the configuration of the femoral condyles. The following case history is offered to illustrate the procedure:

Fig. 3.—Illustrative of the particular kind of anchorage for tibia graft.

Fig. 4.—*A* Roentgenogram of chondrofibrosarcoma. *B* Same patient, 15 months after operation and *C* shortly after operation. *(B and C reversed in printing.)*

A 52 year old male had symptoms referable to the left knee for fourteen months prior to admission. Roentgenograms taken elsewhere suggested sarcoma or localized ostitis fibrosa of the upper end of the tibia. Roentgen therapy was without avail. A biopsy performed before admission yielded a report of sarcoma. The patient refused amputation.

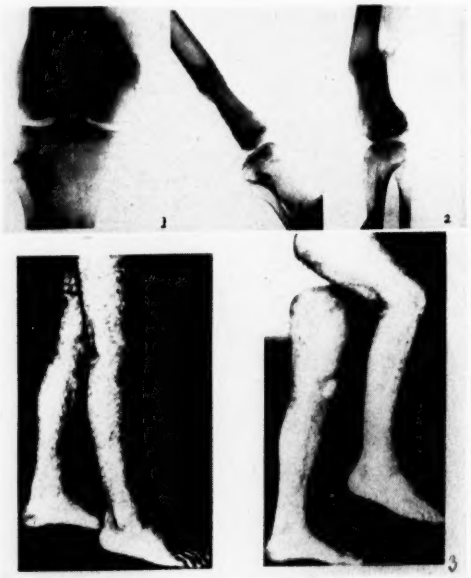

Fig. 5.—1. Fibrosarcoma of lower end of femur. 2. Ten months after operation. 3. Showing range of motion in reconstructed knee joint, ten months after operation.

He was admitted to the I. Surgical Hospital of the University of Istambul on April 17, 1939. Roentgen examination revealed destruction of the upper end of the tibia (fig. 6). There was an apparent perforation of the tumor into the soft tissues. The joint space was narrowed; genu varum had resulted due to collapse of the medial condylus. Biopsy report: friable and highly vascularized tissue which in some places perforated the thinned out cortex.

A (upper); *B* (lower).

The histological examination revealed a conglomeration of giant cells surrounded by bands of spindle cells. The spindle cells were partly polynuclear, of different size and hyperchromatic. There was lacunar resorption of the adjacent bone. The pathologist was unable to decide whether the cells were benign or malignant.

The patient consented to a resection of the diseased bone. Operation was performed on April 21, 1939. The knee

C

Fig. 6.—*A* Giant cell tumor of upper end of tibia. *B* Six weeks after operation. *C* One and one half years after operation.

joint was entered by the Krida utility incision which was extended upward and downward to the middle of thigh and leg. The patella tendon was severed close to its attachment. The tibia was exposed and divided 18 cm. below the line of the joint, excising the tumor completely. About 1 cm. of the articular surface of the femur was sawed off. The medial half of the lower femur was exposed and cut sagitally with a motor saw and chisel. The upper end of the bone graft thus obtained was tapered and plugged into the medullary cavity of the tibia. Through this arrangement

the resected femoral articular condyles coaptated. For better stability, the denuded patella was fastened to both bones by nails (fig. 7). Spica cast was applied

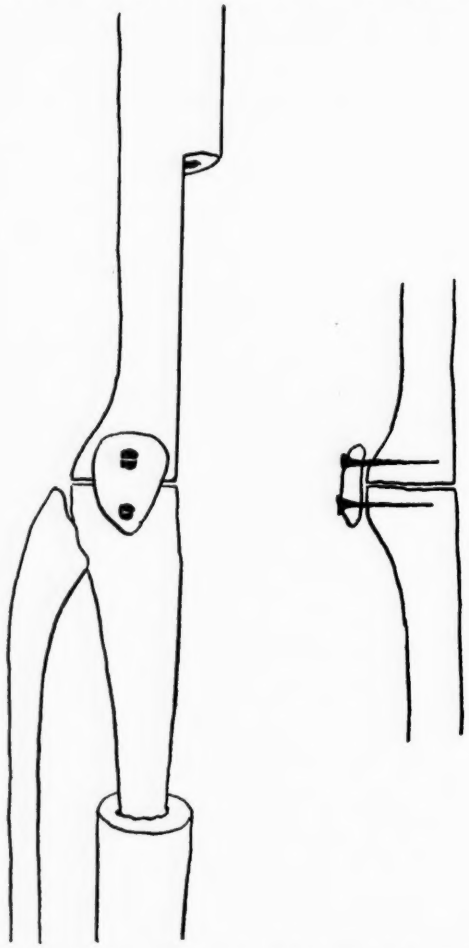

Fig. 7.—Half of lower end of femur used for replacement of tibia defect. Aim is fusion. After economical resection of articular surfaces, bone wounds are adapted and held by denuded patella.

to and including the foot. Although no tourniquet was used, the loss of blood was small. The patient made an uneventful recovery. Roentgenograms taken the second day after the operation revealed the desired position of the graft. The cast was changed after two months. After four months in plaster, a leg caliper splint was applied and maintained for two months. The last roentgenogram was taken 1½ years after the operation. According to a recent communication it was reported the patient was in satisfactory condition five years after the operation.

SUMMARY

Three cases are discussed in which tumors of the lower end of the femur (2 cases) and of the upper end of the tibia (1 case) were treated by resection. The resulting defect was replaced by half of the upper third of the tibia or of the lower third of the femur respectively. Reconstruction of the knee joint at the time of the operation is discussed. (The two cases of femoral resection were described in a previous publication.)

RÉSUMÉ

Trois cas de tumeurs de l'extrémité inférieure du fémur (2 cas) et de l'extrémité supérieure du tibia (un cas) traités par résection sont discutés. La lacune résultant de l'opération fut comblée par la moitie du tiers supérieur du tibia et par le tiers inférieur du fémur respectivement. La reconstruction de l'articulation du genou au cours de l'opération est discutée.

RESUMEN

Se describen tres casos de tumores, dos localizados en la extremidad inferior del fémur y uno en la extremidad superior de la tibia, cuyo tratamiento consistió en la resección. El defecto resultante fué reparado mediante la mitad del tercio superior de la tibia o del tercio inferior del fémur, segun el caso. El autor estudia la reconstrucción de la articulación de la rodilla durante la operación.

Свод

Рассмотрены три случая, в которых опухоли нежнего конца бедренной кости и верхнего конца большеберцовой кости были удалены резекцией. Получившийся дефект, был замещен, соответственно, половиной верхней трети большеберцовой кости или нижней трети бедра. Дана реконструкция коленного сустава во время операции.

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(Continued from page 55)

duction of congenital dislocation of the hip. A full account, including operative technique and postoperative care, is given of a case of congenital dislocation in a child of five, together with subsequent observations over a period of fifteen years following the operation. The latter summarizes earlier progress reports, published at various times of this original operation.

RÉSUMÉ

L'auteur nous décrit les résultats obtenus par différents procédés moddernes employes pour la réduction des luxations de la hanche. Il rapporte un cas de luxation congénitale de la hanche chez un enfant de cinq ans avec la technique opératoire et le traitement postopératoire employés et l'observation de la malade pendant les quinze années qui suivirent l'opération. Il rapporte les résultats obtenus à différentes périodes de ces quinze années.

RESUMEN

Se hace aquí un breve resumen de los resultados obtenidos con varios métodos modernos en el tratamiento para la reducción de la dislocación congénita de la cadera. Se estudia en detalle un caso de dislocación congénita en un niño de cinco años, incluyendo la técnica operatoria, las atenciones postoperatorias y la subsecuente observación prolongada por un período de más de quince años después de la intervención.

Свод

Дан краткий обзор результатов разных модерных способов редукции прирожденного вывиха бедра. Дан полный доклад случая прирожденного вывиха бедра в пятилетнем ребенке, включая оперативную технику, послеоперативный уход и пятнадцатилетние наблюдения после операции. Эта часть доклада включает прежние данные.

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Malignant Tumors of Bone

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PATIENTS affected by malignant tumors of bone seek medical advice because they are suffering pain, discomfort, disability or lack of normal vigor and feeling of wellbeing; have noticed an unusual tumor, tenderness or pulsation, which may have been brought to their notice by an injury—perhaps trivial in nature; or have sustained a fracture.

Clinical Aspects. The pain may be described as but a feeling of discomfort—it may have persisted at the site complained of for some years. It may be severe and agonizing in its intensity. It may come on in bouts with intervals of complete or almost complete freedom, lasting a few hours, days, weeks or even months. It may be unendurable in its persistence. It may be brought on by exercise, pressure, or, more commonly, by jolts or sudden involuntary movements. It may prevent sleep, but it does not as a rule awaken the sleeper as do the lesions which involve the articular cartilage. Usually the joints of the affected part can be moved freely without causing pain; in some cases movements are restricted or abolished owing to the involvement of musculature or nerve.

It may even happen that a large tumor may be felt, or a large lesion indicated on a roentgenogram, yet the patient may say he is free from pain, and little tenderness may be elicited by examination. Again the tenderness may be so exquisite that the patient fears the examining hand. Or, no tumor may be felt, yet the patient complain of pain in several sites. A tumor may be felt which is hard and bony in consistency, or, in some cases, there may be a sensation of crackling, pulsation or fluctuation; true fluctuation is unusual—it may be due to a secondary change. The soft tissues may appear to move freely over it. The skin may be normal in appearance and to the touch. In other cases, where there is rapidly expanding growth, it is often taut, shiny or of a dull, cyanotic redness. The superficial veins over it may be conspicuous in their number and size. Except for the site of the lesion, the patient may look and feel in good health. Another may present a parchment-like skin or show the drawn features of long-endured agony, or the languid aspect and emaciated body of the dying. The temperature may be normal or be elevated as high as 104 degrees.

Fracture may arise from injury. This may have been so severe that the possibility of bone pathology may be overlooked, or so trivial that the extent of the damage may be amazing to both patient and physician. Though the pain of fracture may be less than if it involved normal bone, it is often associated with exquisite and continuous pain from which only morphine will give relief.

No age can be said to be free from the possibilities of cancer of bone, for such lesions have been seen shortly after birth, while others have been essential features in the death of the aged. The type of tumor varies in different age groups.

From this recital of the extreme varia-

Being the final of seven lectures answering the question—What is a bone tumor? Given to American Medical Officers under the auspices of The British Council.

tions in the severity of the signs and symptoms to which patients with malignant bone tumors are subject, it will be appreciated that we can give no one clinical feature which could be regarded as pathognomonic of cancer. Yet notwithstanding the truth of Bloodgood's [1] statement "Less and less, today, are the clinical features of benign and malignant tumors of bone or of diseases of bone helpful in the diagnosis, but they should never be neglected. In former years, when malignant disease could be recognized clinically, there were no cures," the clinical investigation must be thorough. Facts elicited in this way may be the essential ones on which accurate diagnosis depends. The family history may give essential details of dominant or recessive developmental anomaly, dystrophy or disease such as we have seen in the illustrations of the earlier lectures. The personal history of the patient may reveal evidence of past inflammatory disorders, trauma, etc., which may be invaluable in the interpretation of the findings in the subsequent scientific investigations of the case.

Though as a general rule it is wise to fit the whole clinical and scientific picture of the lesion or lesions into one category, be it congenital maldevelopment, familial or deficiency dystrophy, disorder or disease of the skeletal or nervous tissues, viscera, endocrine glands or blood, reaction to trauma or inflammation from any cause, or neoplasm, it must be realized that the presence of a lesion characteristic of any one of these, does not confer immunity against the development of a lesion or lesions in other categories; several may run concurrently. Occasionally the composite picture obtained from the investigations is obscured because of a mixture. For instance, because a patient has a dystrophy, there is no reason why he should not develop syphilis or rickets and there is no reason why a patient with syphilis should not develop sarcoma or vice versa.

Unfortunately, because this interrelationship has occurred and not been recognized, cases in one category have been described as having the well established clinical, biochemical, histological and radiographic features of another, when, in fact the features are due to other influences. Lesions bearing but a very superficial resemblance to well known conditions have been described, illustrated and published as such; these again being quoted or copied into later publications, as the evidence that certain unusual features characterize one or other category. As an illustration, one of the most outstanding conditions to meet with this type of treatment was fluorosis of bone. Because Flemming, Möller, Röholm, and their associates described and illustrated this condition as one which gave added density to bone, there was a spate of cases published under this title, few of which really bore any resemblance to fluorosis and some of the illustrations of these atypical cases (which were in reality cases of such conditions as Albers-Schönberg's disease, Paget's disease, carcinomatosis, etc.) were later used by certain prominent writers for illustration of fluorosis of bone. The editors of some well known journals were even led to teach that Albers-Schönberg's disease was not a rare condition of unknown origin but one which could be produced at will by the ingestion of fluorine!

Special attention should be devoted to the possibility of syphilis. Every investigation into the cause of any bone tumor or suspected case of malignant disease of bone which does not include

a search for evidence of syphilis must be regarded as incomplete and the investigator as negligent. The spirochete can produce lesions which are almost indistinguishable from many so-called typical lesions of other origin. The spirochete is twisted in form and nature, and can at any time twist the unwary. It is found where it is least expected; it is one of nature's most formidable secret weapons.

The appearance of lesions produced by the spirochete may deceive the surgeon even at an exploratory operation; there have been cases in which the histological appearances have deceived the pathologist. But the time for the diagnosis of syphilis is not after exploration or amputation; for the tragedies associated with, and consequent upon the latter, appear intensified to those who realize that even some of the most extensive syphilitic lesions of bone may return to normality after efficient medication.

Many limbs have been sacrificed unnecessarily because syphilitic activity has been mistaken, even by the experienced, for that of cancer. Even age does not need to be considered in syphilis. Geschicter and Copeland record a gumma in the fibula of a child, aged 7, following injury. It was diagnosed as a possible endothelioma; the bone was partially resected and found to be a gumma.

It must not be forgotten that a patient with a sarcoma may have a positive Wassermann, but, distinct from sarcoma, the syphilitic lesion resolves readily and often completely when the patient is put on antisyphilitic medication. I have recorded [2] the case of a young soldier, aged 22, who was sent to a base hospital from the trenches in the last war with a swelling of the thigh. It was explored because it was thought to be an abscess, but no pus was found. After the wound had healed he was sent to a hospital in England where the lesion was diagnosed as an aneurysm of the femoral artery, and an operation designed to ligate the essential vessels was commenced, but a collection of disintegrated muscle was found which was mistaken for pus. It was sent for bacteriological examination and Bacillus histolyticus was reported to have been discovered. For some months the limb was irrigated with eusol in spite of marked expansion and protrusion from the wound, of tumor tissue. Eventually the lesion was seen by Sir Robert Jones who diagnosed sarcoma and advised amputation. The limb was amputated with disarticulation at the hip joint. The patient appeared to make a good recovery and was then transferred to a London hospital to be near his home. After some weeks the administration of this hospital inquired why the limb had been amputated, for the man had a positive Wassermann and was responding well to antisyphilitic medicaments. He died a month afterward and secondary sarcomata were found in the brain and heart. Like syphilis, malignant metaplasia may occur, but less frequently than in the benign tumors, in association with lesions in any of the other categories we have considered. Its possibility at the site of old trauma or an old subperiosteal hematoma has been illustrated. I would also remind you that certain bony lesions which may develop in hemophilia, leukemia and lymphadenoma have characteristics suggesting cancer and that careful examination of the blood may bring valuable evidence for the diagnosis. Nor must we forget that the discovery of Bence-Jones protease in the urine is in itself strong evidence in support of a diagnosis of myelomatosis.

Biopsy. It used to be the practice to conduct an exploratory surgical operation in any case which presented clinical evidence of a bone tumor. While in certain types of case the roentgenographic evidence now available permits this surgical intervention to be dispensed with, in others the abnormal roentgenographic signs appear to act as an incentive to the surgeon to look-see, and obtain material for histological examination. Few surgeons have sufficient number or variety of bone tumors on which biopsies have been performed to enable them to gain an appreciation of the true value of histological examination. As indicated in a previous paragraph, material from an exploratory operation or amputation is not that on which one should depend to find evidence of syphilis or tuberculosis, though this action is not as uncommon as it should be. See what James Ewing said:[3] "The whole clinical and radiological picture of the case of bone sarcoma usually furnishes a better conception of the diagnostic and therapeutic problem than can be obtained from a biopsy. Often the rate of growth, the extent of the disease, and the radiological details indicate the general nature and grade of malignancy of the process better than does the histological structure of the tumour, but this is not always the case. Few surgeons realise the limitation in the histological diagnosis of bone tumours, and the conditions which simulate or accompany them." And again, "In the average specimens of callus, the proliferative activity of fibro-blasts, osteoblasts and endothelioma is quite remarkable, and often presents a picture which is difficult to separate from sarcoma—some organising blood clots after fracture I have found quite difficult to separate from sarcoma." Yet, in spite of this, biopsy is urged for cases which present clinical and roentgenographic evidence of traumatic myositis ossificans; the surgeon concerned not realizing that surgical disturbance of the tissues in the immature phase of this condition may disperse the osteogenic cells over a much larger area, and so seriously retard, or even prevent, complete recovery from the lesion. Though the material obtained, or the preparations made from it, may be submitted to a number of skilled pathologists and be variously reported on, as showing anything from normality to frank cancer, the trauma produced at the operation may so alter or mask the clinical and roentgenographic features that the lesion fails to receive the correct treatment. Let me give two instances to illustrate this. The first was recorded[1] by Geschickter and Copeland. The patient, a male aged 28, while helping to lift an automobile from the mud (apparently about March 1, 1923) felt a sudden sharp pain in the upper portion of his right arm and shoulder. The following day, the arm was tender, also the shoulder and the muscles of the neck on the right side. Some swelling without discoloration was noted, and hot applications were advised by the physician. On April 7, 1923, a marked swelling was found on the outer side of the right arm over the prominence and insertion of the deltoid. The skin covering this appeared normal; neither dilated nor enlarged veins were noted. The mass was indurated, almost bony in consistency, smooth, not lobulated. It seemed to be in the deltoid muscle. Roentgenograms taken at this time (the actual date of the injury is not stated, J.F.B.), showed a definite bone forming mass on the outer side of the right humerus. This was thought to have followed stripping of the periosteum at the insertion of the deltoid, resulting

from indirect violence the month before. There follows a history of progressive enlargement. "A diagnosis of myositis ossificans was made. During September 1924, the mass, which had been enlarging slowly began to grow rapidly and increased 4 cm. in size in four weeks. Pain became more severe and could not be controlled by codein." An operation was decided upon and a large unencapsuled reddish-gray mass was exposed. Considerable material was cut away. "The specimens were examined by several pathologists and a diagnosis of myositis ossificans made. There was no evidence of malignant disease." Later amputation was performed. "One and one half years after amputation there were no evidences of recurrence. The patient looked well." The patient was readmitted on April 19, 1929 (i.e., 6 years after onset), and died shortly after. The autopsy revealed bony masses in the right and left chests—bony metastases were also found in the cervical lymph nodes on the right side," but a record is made that "No cells are seen from which a diagnosis of malignancy can be made." . . . "The clinical history is of prime importance in making a diagnosis in this case. The lesion was progressive from the onset. The course might have been modified by the first operation, for myositis ossificans is apt to be made worse by operation."

The second is from my own experience. A young soldier from Dunkirk was sent for roentgen-ray examination of a somewhat tender mass in the outer aspect of the right thigh. I reported "Typical traumatic myositis ossificans." The orthopedic surgeon in charge of the case consulted me and asked if there were any doubts, for there was no history of trauma. I explained that with the excitement of escape from Dunkirk, it was unlikely that he would notice even severe trauma. The limb was immobilized in plaster. The consulting surgeon examining the roentgenograms diagnosed it as sarcoma and ordered the plaster to be removed. Opportunity was taken to secure more roentgenograms for confirmation. These not only confirmed my former opinion but supplied evidence of a similar but less extensive lesion on the opposite femur. Biopsy was urged but I pursuaded the orthopedic surgeon not to, because (1) at this stage it would still further invalidate the patient, (2) it would provide material which might well be reported as sarcomatous (see Ewing's opinion). (3) If the latter did occur he must take the responsibility of amputating both lower extremities and (4) if he left it immobilized, serial roentgenograms would indicate the nature of the lesion and the patient would run little extra risk. Amputation in sarcoma offers little chance of cure. This advice was accepted and the patient transferred to another hospital where he was used at the Final Fellowship examination of the Royal College of Surgeons. All four professors of surgery agreed that it was a sarcoma and all counselled biopsy. This was performed, but fortunately nothing typical of sarcoma was discovered. After a prolonged convalescence, during which the lesions showed the characteristic roentgenographic resolution, the patient was discharged from the army as unfit, owing to the limitation of movement of the operated thigh.

In previous papers I have illustrated with photographs and roentgenograms lesions of bone which were submitted to biopsy. The histologic examination of the material obtained in some cases which appeared roentgenographically to be simple, resulted in reports indicating high malignancy, yet the patients recovered without any further operative procedure. In others, though the roentgenograms showed features, such as the

irregular periosteal accretions and disintegration or sclerosis of the underlying cancellous tissue which occur in malignant tumor, the histological preparations were reported on as showing "No sign of malignant disease."

It is by no means uncommon to find atypical but very definitely abnormal roentgenographic appearance of lesions which yield histological preparations that are at least equally atypical. In my experience, when the roentgenographic appearance is indefinite, biopsy makes no useful contribution to the diagnosis.

Geschicter and Copeland [1] who, though they advocate biopsy, state, "Frozen sections should be made with an immediate and competent pathologic report, and the operation proceeded with at once. If facilities for frozen sections are not available and consultation is required in the diagnosis, the roentgenograms and not the sections should be sent, as a diagnosis can usually be obtained roentgenologically without the necessity of exploration, if the proper authorities are consulted. This is the method advocated by Bloodgood."

An exploratory operation on an inoperable lesion, whether simple or malignant, I believe to be unjustifiable and even in other cases if it is solely for obtaining material for histological examination, it contributes little to the treatment of the case. A localized resection of the affected bone is more reasonable for it provides the pathologist with the whole lesion from which he can choose his own material; if benign it removes the cause of the trouble, and if malignant it contributes no more to the patient's disability than a biopsy. Extensive exploration with removal of multiple segments from different parts of the tumor, as advised by some authorities, may seriously affect the stability of the bone, yet the material secured by a biopsy needle may be very misleading. There is evidence to suggest that biopsy accelerates the growth of the tumor and may be a factor in its dissemination. In those tumors such as osteoclastoma which are to be treated by X-radiation, the removal of tissue may be equivalent to the removal of the scaffolding on which repair is dependent. If biopsy is decided upon, the lesion should be accurately localized by roentgenography and a skin marking made to indicate the site to the surgeon. It is not unusual for material to be taken from bone away from the lesion shown on the roentgenogram. The material removed should be sent for histological and bacteriological examination. Some degenerated tumor tissue has an appearance which may be mistaken for pus. (See case recorded on page 64.)

Roentgenographic Investigation. John Hunter [6] made the comment "It is surprising to see what little curiosity people have to observe the operations of nature and how very curious they are about the operations of Art." If that was true in his day, how true it is today, though we have in roentgenography a method of observing the inner operations of nature without giving the patient any mental or physical pain. Only too often the roentgenogram is used to obtain a spot diagnosis which is precipitately followed by operative measures instead of using it to watch the development, regression or progression of the lesion before and during the exhibition of medicinal agents.

With the demand for earlier and earlier diagnosis, we are meeting with the early roentgenographic signs of lesions. Though these may be widely different in their pathology, their manifestations may be indistinguishable from one another for a time. It is only by the roentgenographic study of their

development that we can assess their significance. It may be urged that the all-important factor in the cure of malignancy in bone is early amputation and therefore the less time between roentgenography and surgery the better. But there are few surgeons who would care to amputate a limb for a symptomless lesion which had no clinical signs and as yet indistinguishable roentgenographic signs. On the other hand we see for the first time patients with metastases though only a relatively small localized primary is present. We must always bear in mind that the lesion of which the patient complains may be a secondary metastasis. Particularly is this so in patients who have reached middle or late adult life.

Today it is a routine procedure to roentgenograph the affected part as the first step in the investigation. (It would be advisable to study the chest at the same time.) Sometimes this is done before, and sometimes without, any clinical investigation worthy of the name; an important omission which may have serious consequences due to misinterpretation of the roentgenograms.

We have seen that the history of trauma may be of particular significance. In about 50 per cent of cases, the patient will give this explanation for the tumor. From the date of the injury, it may be possible to establish the contribution of trauma to the lesion. As we have seen in the previous lectures, the time factor between the date of injury and the roentgenographic signs, often permits us to determine the nature of the pathological process. As a general rule it will be found from the roentgenogram that the lesion was present long before the injury, the latter merely drawing the patient's attention to a previously symptomless lesion. It is rare to find a malignant tumor with relatively recent bone changes which has roentgenographic appearances likely to be regarded by the experienced observer as having developed since, and as the result of, trauma which produced typical clinical evidence at the time. More often, when the time factor agrees with the roentgenographic appearance, it will be found that the lesion is the result of a simple traumatic or inflammatory reaction. It may be that we are unable to establish this from the first roentgenologic examination, we may require a series of pictures taken at intervals, of a duration dependent on the rapidity of development of the lesion, before we can say whether the lesion is progressing or receding. In my experience, which embraces roentgenologic investigations of injuries received during and between the two world wars, I have seen but two cases of genuine sarcoma arising at the site of a well established trauma. In both of these there had been fractures at the sites more than 10 years previously. In these cases it was the clinical features only which indicated that malignant metaplasia had occurred; the roentgenographs showed what appeared to be merely the effects of the old injuries. I would again stress the importance of roentgenographic investigation as soon as possible after trauma, such pictures may be invaluable in determining the relation of the trauma to any lesion which may subsequently develop. Unsuspected fractures, the so-called "march fractures," receive the trauma of function until discovered, consequently unusual callus may develop at the site, creating appearances which may be mistaken for sarcoma and lead to amputation.

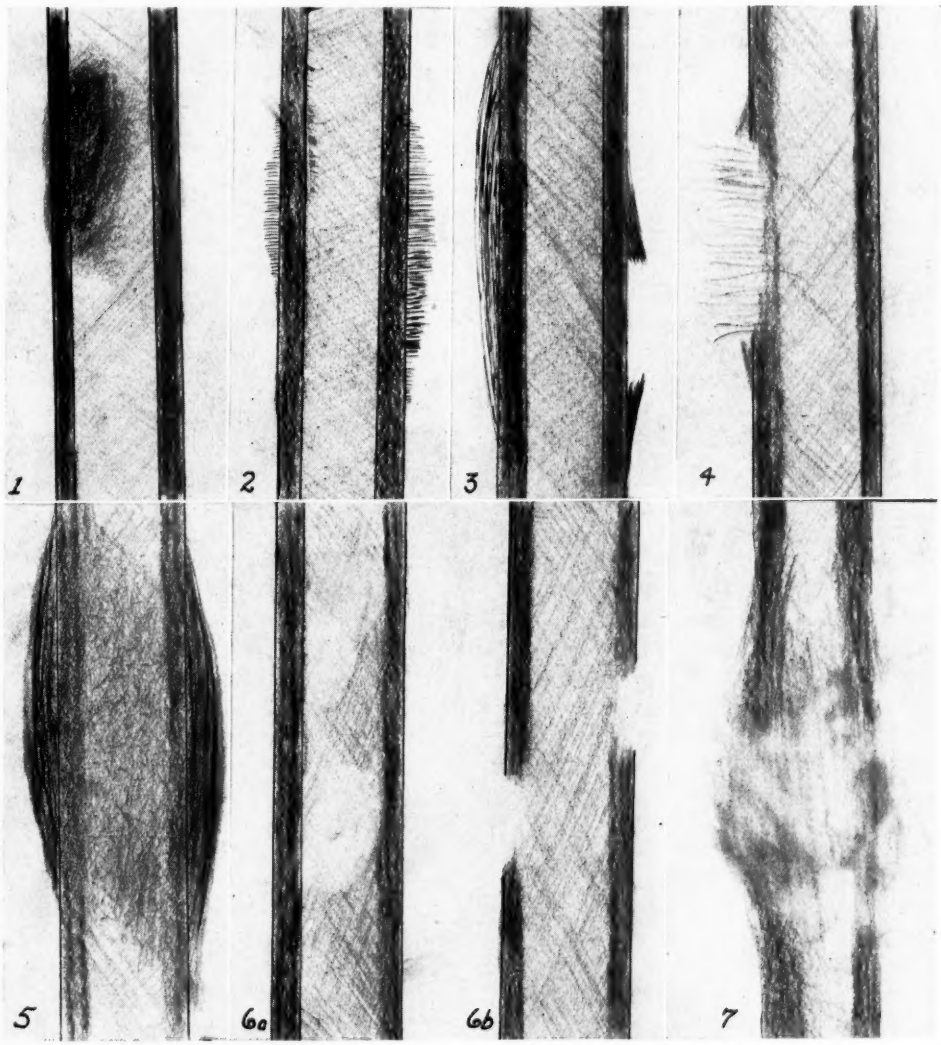
The Roentgenographic Signs of Malignancy in Bone Tumors consist of (see illustration):

(1) Localized, ill-defined, irregular area of increased density in a bone;

(2) Palisade, needle-like spicules at right angles to the periosteal border of the bone;

(3) Periosteal accretions of new bone or cuffs on either side of the primary lesion;

(4) Periosteal irregular fiber-like spicules radiating from a localized area of damaged cortex, usually bounded by a periosteal reaction cuff at both ends;



(5) Localized expansion of bone which is denser than the adjacent normal bone;

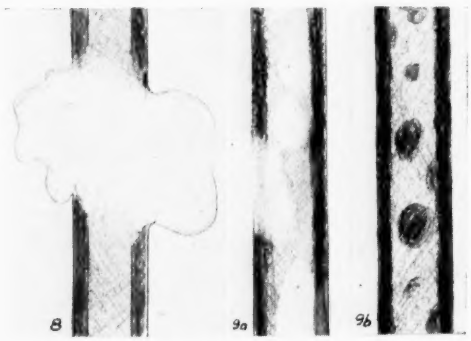
(6) Localized osteolysis of bone either cortical or endosteal;

(7) Localized, irregular disintegration of a previous bony lesion;

(8) Localized, irregular cyst-like extension and expansion of bone;

(9) Metastases in other bones or the lungs; or

(10) Large expanding soft tissue tumor associated with normal underlying bone.



(1) If there is one sign which I regard in itself as more highly suspicious of cancer than any other, it is an ill-defined and irregular localized area of increased density of a bone which has previously not been the site of any definite inflammatory change. This appearance suggests that in this localized area, the interstices of the cancellous tissue have been packed with calcium. The margin of the reactive area on the medullary aspect of the tumor being ill-defined, suggests that the tissue is reacting as the malignant cells gradually infiltrate it—indeed this is the histological picture. The cortex of the segment involved may appear to be irregular and somewhat thicker but no spicules may be seen radiating into the soft tissues. As the soft tissue tumor grows, poorly defined calcium deposits resembling wisps of cotton wool may be seen. Serial roentgenographs will show a progressive spread of this dense reaction in the bone with further irregularity and thickening of the cortex and denser wisplike strands of calcified tissue in the larger soft tissue tumor. After some months, central destruction of the dense bone may occur followed by its decalcification.

Such lesions have been called sclerosing sarcoma of bone. Histologically they show features resembling all forms of connective tissue from the most primitive with irregularly formed and disposed osteoblasts, fibroblasts and osteoid tissue to the more mature myxomatous, chondrous or osseous tissue. This tissue may be regarded as benign, as in the cases I have published.[7] Such tumors occur most frequently in the opposing ends of the diaphyses of the tibia and femur but they are occasionally seen in other bones.

Geschicter and Copeland[1] claim the very high figure of 25 per cent of cures with early amputation. These lesions do not respond favorably to X-radiation. Some metastases from carcinoma of the prostate show as rounded areas of increased density before they coalesce to produce a general increase in the density of the affected bone.

(2) Needle-like spicules radiating in palisade fashion into the soft tissues at right angles to the superficial surface of the cortex of the bone, are another highly suspicious sign, particularly when the spicules are fine, straight and needle-like in shape. As the tumor is watched, it may be seen that, as the spicular growth becomes absorbed at the primary focus, it spreads along the shaft to its extremities. Such periosteal spicular growth may be associated with an increased density of the affected bone, in marked contrast to the apparently unaffected adjacent epiphyses. In some cases of secondary carcinomatous metastases, particularly from the prostate, the periphery of the cortex of the affected bone may appear to be woolly, but on closer examination (of a roent-

genograph taken with a fine focal spot) it will be seen that there are fine, closely-packed spicules ¼ to ½ inch (.625 to 1.25 cm.) in length, forming a plush-like pile. Localized carcinomatous metastases may show an apparent destruction of the cortex with spicules radiating out from the subsurface of the affected segments, but, as with most secondary carcinoma, in contrast with sarcoma, there is usually little soft tissue swelling. In Ewing's sarcoma, the bone may have shown initially a segment of expanded bone with a thickened and denser cortex which has a regular periphery but an irregular, coarse cancellous trabeculation within. However, after injury to the bone, accidental or surgical, fine radiating spicular growth may be seen at the site.

Some localized syphilitic bony lesions, as well as the bone beneath an indolent ulcer, such as a varicose ulcer, may show what have been described as spicular growth, but this is coarser and quite different in appearance to the radiating spicular growth of sarcoma—it is more a response to inflammation of the periosteum.

(3) Periosteal accretions in themselves are not the sure sign of cancer which is so often taught. Multiple periosteal accretions which run parallel with the periphery of the cortex, associated with more or less complete obliteration of the normal cancellous pattern within, is seen in Ewing's sarcoma, but localized chronic inflammatory lesions, particularly syphilitic, are indistinguishable. When the periosteal accretions are broken down in the middle so that they form a cuff on either side of the primary focus, with its greatest dimension toward the lesion and gradually diminishing in caliber away from the lesion, the appearances are more likely to be those of sarcoma, particularly if there are in the soft tissues over the neighborhood of the primary focus, ill-defined wisps of calcium deposit. In Geschicter and Copeland's book,[1] it is stated that "Periosteal bone formation is rarely present in tubercular osteomyelitis"; this is a misstatement for periosteal accretions are common in tuberculous osteomyelitis. They may form a very expanded involucrum within which the original shaft is destroyed leading eventually to the appearance called "spina ventosa." In other cases the accretions may show as multiple parallel deposits usually over a fairly well defined area of destruction of the original bone and perhaps an indication of a poorly defined sequestrum within the focus. In some cases, the periosteal accretion in tubercle is fleeting—present at one examination and gone the next, to reappear with a further phase of activity.

Periosteal accretions may be seen over a Brodie's abscess during a phase of reactivity and over normal bone or a simple cyst or bone tumor which has been subjected to trauma or inflammatory changes a week or so previously. Acute osteomyelitis which has been diagnosed in its early stages and aborted by treatment with sulfathiazol or penicillin may show a periosteal cuff and irregular spicules in association with an adjacent localized area of decalcification which roengtenographically may be indistinguishable from sarcoma, while in the early stage the affected diaphysis may show some degree of osteoporosis, as the result of effective treatment, it may develop a density which is in contrast with the unaffected epiphyses. The reactive changes at the site of an incomplete fracture, in a patient who does not remember trauma to the site which is now painful, have been mistaken for evidence of sarcoma.

In leukemia, localized periosteal accretions may be associated with an adjacent area of decalcification.

The periosteal hematoma which is undergoing calcification is distinctive. Its appearance in scurvy, particularly when it occurs in the patient with osteogenesis imperfecta, has been described.

The histological features of tumors having this periosteal reaction show considerable variation. They are variously reported as round celled, spindle celled, Ewing, chondroblastic, or chondromyxosarcoma.

(4) From the surface of a localized area of damaged cortex, which appears to be diminished in caliber (its borders are usually indicated by a periosteal reactive cuff which is fairly clearly defined) calcified fibers radiate into a large adjacent soft tissue tumor. These calcified fibers do not present the fine sharp palisade spicular appearance, for they are irregular in calcification, distribution and outline. Small faint floccular deposits of calcium may be present in the neighborhood. At a later period, calcium may be more widely deposited and outline the large soft tissue tumor. Only one surface of a localized area of bone may appear to be involved, the remainder showing normal characteristics. These tumors may be seen on the middle third of the shaft of a tubular bone or nearer the ends of the diaphyses.

The soft tissue tumor appears to be massive compared to the size of the bony lesion. They usually present the histological features described as a chondrosarcoma or chondromyxosarcoma. They are most common during the ages of ten to thirty but isolated examples are seen at other ages. Fracture of a sarcomatous bone may result in localized decalcification of the ends of the fragments over an area of one or two inches (2.5 to 5 cm.) and the periosteal borders of this area may show considerable fiber-like irregular spicular growth.

Some metastases from such lesions as carcinoma of the lung may be associated with a somewhat similar roentgenographic appearance.

(5) More commonly in infants and young adolescents, a bone tumor will be found which is characterized by the roentgenographic appearance of a localized regular expansion of bone associated with an increased density, a thickened cortex and obliteration of its cancellous interior—though the medullary cavity may appear to be widened or narrowed and somewhat mottled in appearance. The periosteal periphery may be quite regular and show no sign of spicules or localized destruction. It appears to progress very slowly if it is undisturbed, but if injured by trauma, accidental or surgical (as for biopsy) a crop of palisade periosteal spicules may develop at the site. In some cases, spontaneous fracture occurs through thickened denser bone and this is followed by the development of spicules and considerable decalcification; the bone may now appear to be undergoing dissolution. Ultimately these trabeculae disappear. Secondary deposits of this nature may develop in other bones in the course of from a few months to two to three years. Multiple secondaries may also occur in the lungs. The histological features are usually those of a Ewing sarcoma. Any bone may be involved but the upper end of the femur and the shafts of the long tubular bones are the most common victims.

(6) Localized osteolysis of bone may be either cortical or endosteal. The cortical lesion is usually insignificant compared with the large soft tissue tumor. This type of lesion is more commonly found at the lower end of

the femur and the upper end of the tibia. From one aspect, the bone appears to be gradually dissolving away, often without any sign of calcium deposit in the soft tissue or reaction in the adjacent bone, but in some cases the bony periphery of the tumor shows some reaction which is indicated by an ill-defined increase in density. Gradually the tumor destroys the bone but it is not until it has passed through a large segment of it that the periosteum of the other side registers any reaction. Eventually it may show a linear parallel accretion of new bone before fracture or complete dissolution of the segment occurs. The periosteum of the adjacent segment of bone may show a similar reaction. In the rapidly growing tumor no sign of reaction is seen, only a progressive dissolution and decalcification. In some cases the tumors arise endosteally. The involved segment of bone shows localized irregular cancellous destruction which may be interpreted as a bone cyst, but, on closer examination, it will be seen that the trabeculae are eroded at its periphery in an irregular manner; there is no clearly defined margin and no reaction either in the adjacent bone or the overlying cortex or periosteum. Fracture of the bone may be the first indication, for previously no tumor could be felt. Following fracture, more rapid dissolution of the involved area occurs and a tumor becomes apparent. These tumors often metastasize early. Secondaries may be discovered in the lungs at the first examination, though the primary tumor at that time is not large and has not attracted the patient's attention for more than three or four weeks. Such early secondaries have been seen in young persons under 20 years of age.

Because of the complete destruction of a localized section of bone (and as it expands it erodes all bone it comes into contact with, as is particularly well shown when it affects the dorsal spine and ribs) and the large soft tissue tumor, this sarcoma is likely to be mistaken for a tuberculous or more acute inflammatory process with its accompanying abscess.

Some of these lesions respond to X-radiation and consolidation occurs in sites which appeared to have been completely destroyed. In others, the dissolution persists in spite of the radiation. Such tumors present a histological appearance which has been variously described as neurosarcoma, chordoma, osteolytic sarcoma. Some metastases from carcinoma of the prostate, thyroid, etc., present these roentgenographic features.

(7) At the site of an old injury to bone, an osteoma, chondroma, osteochondroma, fibroma, organized subperiosteal hematoma, simple or multilocular bone cyst, Paget's disease, or an old osteoclastoma, a soft tissue tumor develops rapidly and roentgenographs show an irregular destruction of the mature bony elements. The clearly defined details of the structure of the adjacent bone are in contrast with the "mush" at the site where malignant metaplasia is developing. Such tumors may develop 10 or 20 years after the patient had noticed the original lesion. They usually have the histologic features of a chondrosarcoma or chondromyxosarcoma. Amputation in some cases appears to give 5 to 10 years relief but in other cases which are indistinguishable, secondaries develop early.

(8) Large cyst-like expansions of bone, are quite different in appearance to the simple or multilocular cyst, in that they extend much beyond the normal periphery, sometimes to such an extent that they may be two or three

times the caliber of the adjacent bone. The latter may appear to be quite normal in appearance but may have undergone some degree of atrophy from disuse. The affected segment has lost all its normal structure. It may have the appearance of coarse foam or soap bubbles. It has a thin wall which appears to be calcified or incompletely ossified, through which fractures occur. These lesions may be found in young adults with lymphosarcoma, but are usually secondary metastases — often from carcinoma of the kidney (hypernephroma). Or they may be solitary and the patient may get relief for a varying period by resection or amputation. They do not as a rule respond to X-radiation.

(9) The discovery of multiple metastases in the bones or lungs is unquestionable evidence of cancer. The commonest sarcoma to metastasize into bones is that described by Ewing, but carcinoma of the breast, prostate, kidney, suprarenal glands or thyroid, to give but a few primaries, commonly metastasize into the bones. Other sarcomata usually metastasize into the lungs. It is advisable in all cases of bone tumors to take a roentgenograph of the lungs at the same time as that of the tumor. The discovery of metastases has an important bearing upon the surgical or therapeutic procedure to be adopted. But it must be remembered that multiple foci may develop in the lungs in association with an inflammatory lesion of bone. Sulfathiazol or penicillin may cause resolution. The roentgenographic appearance of metastases show considerable variation: (*a*) ill-defined rounded areas of increased density which ultimately expand and emerge to produce a bone which is uniformly denser than the normal (this type is seen from primaries in the prostate or alimentary canal); (*b*) localized areas of osteolytic destruction of the cortex or medulla—the progressive development in the former may lead to complete disappearance of the affected bone. The medullary metastases may be isolated or multiple and merge to leave merely a shell of bone which may show more or less expansion—sometimes two or three times the caliber of the normal bone. These fracture readily. This type is seen from primaries in the breast, prostate, thyroid, kidney and genital organs; (*c*) a combination of (*a*) and (*b*) occurs more frequently in carcinoma of the breast; (*d*) multiple small well defined round areas of cancellous destruction. The medullary cavity of tubular bones may be expanded by scalloping of the inner cortical wall by the multiple rounded tumors. In myelomatosis such lesions may be seen in all elements of the bony skeleton but they are particularly evident on the ribs, skull and pelvis; (*e*) localized areas of erosion of the cortex with irregular density of the subjacent bone and spicules radiating from the lesion into the soft tissues. Such foci may arise from carcinoma of the breast or prostate; (*f*) diffuse decalcification of a bone or of much of the skeleton—this type is most frequently seen in infants and young adolescents in whom it will be seen that while the diaphyses are extensively involved the epiphyses may appear to be relatively spared.

Metastases in the bones often give rise to considerable discomfort or pain whereas metastases in the lungs may be so large and extensive as to leave little lung tissue, yet give no indication of their presence until the dyspnea near the end.

The period which elapses between the discovery of the primary lesion and the

appearance of metastases shows considerable variation. In some cases of carcinoma, a single metastasis in the bone may give rise to symptoms and be recognized months before the primary has been detected or even suspected. In one case where I had reported widespread carcinomatosis of the skeleton, the primary in the breast was not discovered until the postmortem. In other cases metastases may not develop for 20 years or more after amputation of a structure containing the primary carcinoma.

Metastases from sarcomata may be detectable when the patient is first presented for medical examination. Because of this the chest ought to be roentgenographed at the same time—this certainly ought to be done and the Wassermann test taken before any surgical intervention. Isolated or even multiple syphilitic lesions in bone may mimic these appearances of metastasis but as a rule they show some reaction in the surrounding bone whereas the malignant metastases are usually without any evidence of reaction in the peripheral bone.

(10) The tumor in the adolescent or young adult which presents the appearance of a soft tissue tumor associated with normal underlying bone is the highly malignant periosteal sarcoma. Though the tumor reaches great dimensions, there may be no change in the involved bone, but in some cases there is a suggestion of hypertrophy of the compact cortex, and, in the last phase, there may be a thin periosteal accretion or very faint spicules. The clinical, histological and roentgenographic features may confuse, as in the case of the young soldier recorded on page 66. In the adult, a large soft tissue tumor without changes in the bone, may show in the region of the primary focus as an ill-defined deposit of ectopic bone. This is the fibrosarcoma which is much less malignant and may not return even with localized excision. Here amputation is usually a success.

These appearances, particularly those described under (3), (4) and (5), may be modified by antibacterial and antisyphilitic medicaments such as sulfathiazol, penicillin, etc.

Some cases of osteomyelitis, aborted by such medicaments, have, for a period, presented the roentgenographic signs which have been regarded as typical of sarcoma but have gone on to complete resolution. Because of this I have advised the administration of such agents where all the evidence has indicated sarcoma. In one such case (a child of 2 years, with clinical and roentgenographic evidence which was regarded as hopeless sarcoma with multiple metastases, which eventually appeared to have destroyed most of the lungs) I advised a course of sulfathiazol and to the amazement of all concerned, the bone lesions resolved, the metastases disappeared from the lungs and the child appears to be restored to complete health.

Treatment. In the lecture on benign tumors of bone, it was pointed out that up to 10 per cent of some of these lesions undergo malignant metaplasia. We know that partial removal of these lesions is followed by recurrence in a similar percentage of cases. This has an important bearing on the treatment recommended for these tumors. It would seem reasonable to advise complete resection of the bone segment bearing one of these tumors whenever it is possible to do so without the destructon of an important joint or function; the gap being bridged where necessary with a suitable graft. Some cases, from their site and extent, may

not permit of resection, and curettage may be done, but this can never give the security of resection. I have seen malignant metaplasia develop in a curetted site as long as 20 years after, though there was an apparently free and symptomless interval.

Where, without disabling the patient, neither resection nor curettage can be done effectively to lesions which are sensitive to X-radiation, as in some cases of osteoclastoma, it is advisable to expose them to a course of deep X-radiation without any surgical intervention, save only that which secures immobilization.

John Hunter said,[6] "To perform an amputation, is to mutilate a patient we cannot cure: it should therefore be considered as an acknowledgment of the imperfection of an art," but with the imperfect knowledge of sarcoma we possess, amputation appears to offer the only chance of cure we have in the majority of cases. Because of the development of metastases there is a prompting to precipitate action. This, before careful investigation, has resulted in the amputation of limbs and even loss of life for simple lesions. To prevent this, some surgeons place reliance on biopsy and microscopic examination of frozen sections before completion of the amputation.

The histological features of certain typical tumor tissues are so clearly indicative of cancer that the student can be pardoned for thinking that resort to biopsy would permit of ready and accurate diagnosis. Unfortunately some preparations of bone, from the site of hyperemia induced by trauma or other inflammatory agent, from callus, from so-called myositis ossificans, from osteoma, from osteochondroma, from chondroma, from chondromyxosarcoma present characteristics likely to be misinterpreted by different pathologists as indicating some other member of the group. Even of the same specimens opinions may range from normality to high malignancy. The same has occurred with preparations of bone from a site recently subjected to trauma, from mere inflammatory foci or simple cysts, to multilocular cysts, the so-called osteitis fibrosa, osteoclastoma, and osteoblastic sarcoma. Roentgenographic observation over a period of time with the affected part immobilized, would indicate in the majority of cases the malignancy of the lesion, and, though this introduces delay and danger from metastases, it must be recognized that metastases may not only be seen at the first examination or before the operation, but may be present yet insufficiently developed to permit of visualization by roentgenogram, for there is a latent period between onset and visualization which varies with the rate of growth. Hence metastases are frequently discovered within a few weeks or months of amputation, even though this appeared to be prompt. The balance of evidence suggests that in doubtful cases, the treatment of choice would be immobilization of the part for a reasonable period, which would depend on the condition of the patient and the tumor. During this period, the part involved and the lungs should be carefully observed by serial roentgenographs. Lesions due to trauma would be seen to resolve; in certain cases, the effect of medicaments which are antisyphilitic or antibacterial could be observed. As indicated in a previous paragraph some inflammatory lesions of bone produce appearances of the types (3), (4) or (5) which may be associated with multiple rounded opacities in the lungs showing progressive development. I have seen such lesions resolve following

administration of sulfathiazol. In view of the apparent hopelessness of such conditions, administration of sulfathiazol, penicillin or other antibacterial drugs is advisable; it may bring a surprising resolution. In other cases, the response to X-radiation may prove useful. The blood and urine should be examined and a search made for septic foci. If the lesions still show no signs of resolution yet do not show malignant characteristics, resection of the affected bone could be done and the part submitted for histological examination. As soon as malignant features express themselves, if no metastases can be demonstrated, prompt amputation appears to offer the only chance of cure.

X-ray and radium radiation has had a long trial. They have produced but few cures; therefore, while attention should be given to find why the latter responded, a wider field of research ought to claim attention rather than persist with a constant repetition of futile methods. Interpretation of the roentgenological evidence of bone tumors necessitates a wide experience in bone pathology; the same can be said of the clinical and histological evidence. It is unlikely that this experience is to be obtained in any general or surgical practice because of the relative scarcity of the many different lesions; therefore investigations of these cases could best be carried out in some central clinic.

RÉSUMÉ

Les différentes manifestations des tumeurs malignes des os sont énumerées et décutées. D'autres conditions, telles qui la syphilis, peuvent simuler ces tumeurs, des diagnostiques erronés peuvent entraîner des amputations inutiles. L'auteur mentionne différentes méthodes diagnostic et aussi les dangers de différentes méthodes routiniéres, telle que la biopsie. Il importe d'éliminer la présence de métastases pulmonaires. Il faut étudier plusieurs plaques radiographiques et ne pas se baser sur une seule plaque. Plusieurs cas sont cités et les différentes méthodes de traitement sont discutées. C'est la dernière de sept conférences en réponse à la question—"Qu'est ce qu'une tumeur des os?"

RESUMEN

Se discuten y describen en detalle las manifestaciones ampliamente variables de los tumores óseos, mencionándose conjuntamente otras alteraciones, tales como la sífilis, que pueden similar las proliferaciones malignas, haciendo realzar la importancia de los diagnósticos equivocados y los peligros de las amputaciones innecesarias. Se estudia el valor relativo de varios métodos diagnósticos y se apuntan los peligros que muchas veces llevan consigo ciertos procedimientos corrientes tales como la biopsia. Se pone de relieve la importancia de descubrir las metástasis, especialmente las pulmonares. Asimismo se aconseja la realización de exploraciones roentgenográficas seriadas, en vez de conformarse con una sola placa. Se citan brevemente en éste trabajo algunos casos ilustrativos y como conclusión se ofrece una discusión general de métodos de tratamiento. Este trabajo constituye el final de una serie de conferencias sobre el tema: "¿Qué es un tumor óseo?"

Свод

Даны подробный список и соображение всех широких варияций симптомов злокачественных костных опухолей. Упомянуты разные другие болезни, как сифилис, симулирующие эти опухоли, а также опасность ошибочного диагноза и излишних ампутаций. Дана относительная оценка различных диагностических

мер, а также опасность некоторых общепринятых способов, как биопсия. Подчеркнута важность разыскания метастазов, особенно легочных, а также то, что на рентгеновские серии можно гораздо больше положиться, чем на единственный снимок. Даны краткие примеры и, в заключение, общий обзор способов лечения. Это последняя из семи лекций по вопросу "Что такое костная опухоль?".

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Hands Across the Sea

THE ROYAL COLLEGE OF SURGEONS OF ENGLAND

THE International College of Surgeons, together with its United States Chapter, recently transmitted to the Royal College of Surgeons of England, the sum of two thousand dollars, to be used for the proposed reconstruction of the physical facilities of the British organization, which had been partially destroyed during the "Blitz". Thus, once more, with the return of what it is hoped will be a lasting peace, have American surgeons and their colleagues been able to give concrete expression to their belief in scientific internationalism.

It is the sincere hope of the sponsors of the original gift from the International College, that individual Fellows and others, will also feel moved to make some personal contribution to the same cause, in the interests of international scientific liaison. Checks should be made payable to "The Royal College of Surgeons of England" and sent to the Treasurer of the International College of Surgeons, Dr. William Seaman Bainbridge, 34 Gramercy Park, New York City, 3, for transmission to the proper authorities in Great Britain.

In a letter of acknowledgment to Dr. Désiderio Román, President of the International College of Surgeons, Sir Alfred Watt-Johnson, President of the Royal College, said, in part,

"My colleagues and I are extremely grateful for the spontaneous gift . . . to the Restoration and Development Fund of our College which was so seriously damaged by enemy action. . . .

"We look forward to the time when we shall have made our College an even more worthy headquarters of British Surgery, than it has been in the past, and we hope in years to come to have many opportunities of welcoming our colleagues from other countries in our restored and extended buildings."

Such expressions of appreciation, while most gratifying to all who receive them, are actually but one more strand in the web which holds together those of mutual interests throughout the world, without cognizance of race, creed or international boundaries. The War just ended was a scourging evil, but like all evils, no matter how great, it had its beneficial aspects. Not the least of these was the urge, upon all decent peoples, to demonstrate, in whatever way came to hand, the true oneness of Mankind throughout the earth.

An Appeal for a More Radical Attitude in the Treatment of Bone Cysts and Giant Cell Tumors

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MUCH attention has been devoted to the study of bone cysts and giant cell tumors for about a century. Theories put forward to explain these conditions have, in the course of time, changed in a way interesting for pathologists and surgeons alike.

The first question to be discussed was that of the benign or malignant nature of these newgrowths. The classical descriptions dating back to the middle of the past century by Lebert, Virchow and Nelaton leave this question unanswered and none of the authors offers a definite opinion in this respect. The most illuminating of the three is Nelaton, who, when speaking of these "tumeurs a myeloplaxes," emphasized their benign character provided operation is sufficiently extensive.

A similar viewpoint was held by Paget (1853) who, although maintaining the benign nature of the giant cell tumors, admitted that, on the other hand, several of his cases showed a malignant development.

However, for decades the tumors have been regarded as "giant cell sarcomas" and amputation has, therefore, been the method of choice. Retrospectively, it appears that the comparatively favorable follow up figures referring to amputated sarcomata may be explained by the fact that the statistics include a certain proportion of "giant cell sarcomata" in which amputation was unnecessary.

Apart from improved Roentgen-ray diagnostics and the progress in the pathological recognition, a further step forward in the development of the diagnosis of this disease is marked by a statement by W. B. Colley (1907) and Bloodgood (1910) implying that radical operation in giant cell tumors is unnecessary as they do not represent metastatizing sarcomas but benign newgrowths which should be looked upon not as "giant cell sarcomas" but as "benign giant cell tumors." Mikulicz (1904) referred to the affection as "osteodystrophyia cystica juvenilis" and Stenholm (1924) demanded the inclusion of all these diseases into a group of "osteodystrophyia fibrosa."

Thus amputation was soon abandoned and curettage became the method of choice in the surgical treatment of giant cell tumors. The swing of the pendulum in a conservative direction had its repercussions, in that local recurrences were much more frequent than was to be expected in a benign newgrowth, and there was further the necessity of subdividing the giant cell tumors according to their clinical aspects.

The reason for this was that in the meantime it had been possible to recognize generalized osteitis fibrosa or *osteodystrophia fibrosa generalisata,* known since the time of Recklinghausen, as an expression of hyperparathyroidism (Mandl, 1925, 1926) and to separate all other types of localized fibrous osteitis, from the generalized one, clinically as well as particularly chemically. In localized osteitis fibrosa (bone cysts, giant cell tumors) no changes of the calcium, phosphorus or phosphatase values in the blood are demonstrable

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(Mandl, Snapper, Hunter *et al.*). Today, therefore, this differentiation is so well understood that all the varieties of the above-mentioned disease may be once and for all distinctly separated from the generalized type. Maintaining that the solitary bone cyst only constitutes a certain type of osteitis fibrosa or giant cell tumor, Geschicter and Copeland suggested, in 1936, the following grouping; solitary bone cysts, variants of bone cysts or acute bone cyst, benign giant cell tumors, recurrent giant cell tumors, malignant variants and "the metastatic groups."

In 1936, E. Freund and Meffert referred to the "different forms of non-generalized fibrous osteodystrophy," describing them as cystic and solid localized lesions of osteitis fibrosa, multiple localized lesions, diffuse monostotic lesions and *osteodystrophia fibrosa unilateralis* thus stressing the contrast to the generalized types, the latter responding to parathyroidectomy.

The pathogenesis of the giant cell tumors and bone cysts has been the subject of comprehensive studies and it was even possible to produce bone cysts experimentally (Nissen, Mandl).

The discussion on the nomenclature is, however, still in progress; sharing the premise of many authors that bone cysts (whether acute or latent), giant cell tumors, *osteitis fibrosa localisata,* osteodystrophy, osteoclastoma are all variants of a pathologically uniform entity presenting a characteristic microscopic picture, the only point of importance—apart from insignificant differences in the clinical aspects, as a rule, due to the patient's age—is the further development of the process.

On the whole, it must be said that the conservative operative method so widely employed in the past few decades, does not deserve the high reputation attached to it; it has become necessary to revise our therapeutic attitude.

What are the therapeutic results as reported by a few outstanding authors?

H. W. Meyerding (1936) reviews 61 cases of giant cell tumor, in seven of which irradiation was performed after biopsy, eleven were curetted, received bone grafts and irradiation, three had resection, thirteen amputation. Up to 1936, all of these patients, save one who succumbed to embolism, were still alive. Striking is the high proportion of amputations.

In 1935, Freund and Meffert pointed out that among their twelve cases of osteitis fibrosa in which treatment consisted in curettage and bone chips, no more than two showed definite and permanent improvement after the operation. Among the five cases receiving Roentgen-ray treatment only two showed a good response. If radical operation were impossible, amputation was recommended. "Thus we quite often find the topic of localized osteitis fibrosa treated in textbooks of surgery with great confidence and optimism as far as treatment and prognosis are concerned. Nevertheless, every surgeon of some experience with cases of localized osteitis fibrosa, knows that such cases do not always do as well as one would expect from textbook descriptions." "Local recurrences are quite frequent and functional impairment of the affected extremity is by no means rare."

Geschicter and Copeland (1936) reviewing 214 cases over the past forty years, report thirty amputations and thirty-four resections; of the 105 treated by primary curettage, recurrences developed in thirty-one, in which resection or amputation had to follow. The rest of the cases received various kinds of treatment.

The reasons for the frequency of re-

currence are, according to Geschicter and Copeland; incomplete operation (curettage), poor selection of the type of treatment and the tendency of patients over thirty to develop recurrence. While, therefore, after curettage recurrences were very frequent, they were not reported by the authors after resection with subsequent bone grafting!

In the meantime, H. W. Meyerding (1945) also revised his opinion. While from 1913 to 1938 he performed excision and bone grafting in no more than eighteen cases, he reported on twenty-two cases in which this method was employed for the past four years (1939–43). The change in his attitude toward greater radicality is obvious.

While Phemister (1938) rejects the radical approach in giant cell tumor or osteitis fibrosa, Inclán (1940) defends the radical viewpoint and particularly rejects curettage as a routine measure, pointing out that in the case of recurrence only extensive resection with subsequent bone grafting holds promise of success.

The reasons for which we have practically abandoned curettage in bone cysts and giant cell tumors and have, in an increasing measure adopted a radical attitude, are the following:

(1) *a.* When in 1925 I was in a position to report cure of the first case of *osteitis fibrosa generalisata* by removal of a parathyroid tumor, at the time when the patient was still in hospital his sister called on us and gave the following history for herself: For the past few years she had repeatedly hit her tibia at the same place. In 1918, swelling was noted and was diagnosed as periostitis. After a few months, the swelling subsided and she had no pain. In 1921, she fractured her tibia at the place where the swelling had formerly been. Her leg was placed into a plaster cast with which she was able to walk about. While the leg was still in plaster, another fracture occurred and the plaster cast was renewed. Seven months later the tibia again fractured at the same place. This was the condition when we saw her. She was admitted to Hochenegg Clinic, where a roentgenological diagnosis of "osteitis fibrosa" was made. In 1928, when the symptoms recurred, I performed excochleation on the tibia. Microscopically (J. Erdheim) the affection was identified as a giant cell tumor. For some time the patient did rather well. (The roentgenograms are no longer in my possession.) In 1931, an osteogenic sarcoma developed in the same tibia and amputation was inevitable. This operation was performed by another surgeon. There is no doubt, however, that the histological findings were correct.

b. In 1938, just before the occupation of Austria, I saw a patient on whom I had performed excochleation of the tibia on account of a giant cell tumor (histologically verified) and who had, after a few months, developed a recurrence. Renewed histological examination reveiled an osteogenic sarcoma and the patient was advised by another surgeon to have her leg amputated. Unfortunately I knew nothing about the further development of the case, but the surgeon, who is now living in America, may recall it.

(2) Although I am unable to give accurate figures as I am no longer in possession of the material, I am sure that a certain proportion of those cases in which up to 1938 I performed curettage only, developed recurrences, later calling for radical excision or resection.

(3) As to the possibility of malignant degeneration of giant cell tumors which are, primarily, always of a benign nature, leading to local recurrence but

never developing distant metastases, opinions have lately changed:

Thus, e.g. Geschicter and Copeland reported upon eight cases of the "metastatic groups" of giant cell tumors. The question as to whether metastasizing of these tumors is possible (actually it never occurs) is not so important to the authors as the fact that after improper treatment they will undergo malignant change and give rise to osteogenic sarcoma—a question which they answer in the affirmative. Such a case is described in detail.

In a discussion of H. W. Meyerding's paper (1945) Inclán reports two cases with intrathoracic metastases of giant cell tumors which he saw since last publication in 1940, and Leslie Mitchell gives a description of three cases of malignant degeneration of giant cell tumors or bone cysts after roentgen-ray therapy. Ranschoff also reports sarcomatous degeneration in a case of giant cell tumor.

In 1942, Copeland pointed out that "there is increasing evidence that a definite percentage will show malignant degeneration." B. L. Colley and Higginbotham believe that the chance of malignant degeneration of giant cell tumors is enhanced by its chronic persistence, or by incomplete surgical treatment, particularly, if the latter is combined with roentgen-ray therapy.

Comprehensive studies on the subject have recently been made by Stuart, B. L. Colley and Farrow on the basis of microscopic examinations and follow-up data. From a pathological viewpoint, seven cases are analyzed on which sarcomata developed from giant cell tumors.

OUR OWN MATERIAL

From 1940 to 1945, accurate observation was only possible for us in fifteen cases, although we saw a few other cases which could not be followed up. Follow-up periods are not, therefore, very long, but the material is interesting in view of the histories and preliminary treatment, and allows of certain conclusions.

The case reports—with reproductions of the roentgenograms where this seemed worth while—are given as briefly as possible. It should be mentioned, however, that chemical examinations (calcium, phosphorus, phosphatase) made as a matter of course, yielded no pathologic indications.

It may be said in anticipation, that according to our experience *every* single case of roentgenologically verified bone cyst or giant cell tumor in an elderly individual, calls for surgical intervention if it were only for the reason that developments may take a surprising turn, even when the roentgen-ray aspect is a typical one. One of us (F. Mandl, 1930) published two cases of this kind in one of which a typical cyst of the upper arm turned out to be a metastasis of a thyroid adenoma, while in the other (after amputation of the thigh had been advised by another surgeon) biopsy examination revealed a giant cell tumor in which resection very soon restored normal conditions. Where I am working now, some time ago a solitary "bone cyst" in a man 50 years old was curetted (excision was impossible on account of profuse hemorrhage). The histological diagnosis was, however, one of "hypernephroid," but rather surprisingly the cyst had in the meantime rapidly healed.

In view of this and similar discrepancies (cf. int. al. Luedin) which are again and again reported, it is at least advisable to perform a diagnostic biopsy and the outcome of the histological examination should guide us as to the extent of the operative intervention.

REPORTS OF CASES

CASE 1.—S. G., aged 31, was admitted on September 9, 1940.

HISTORY—Since December 1939 he had had

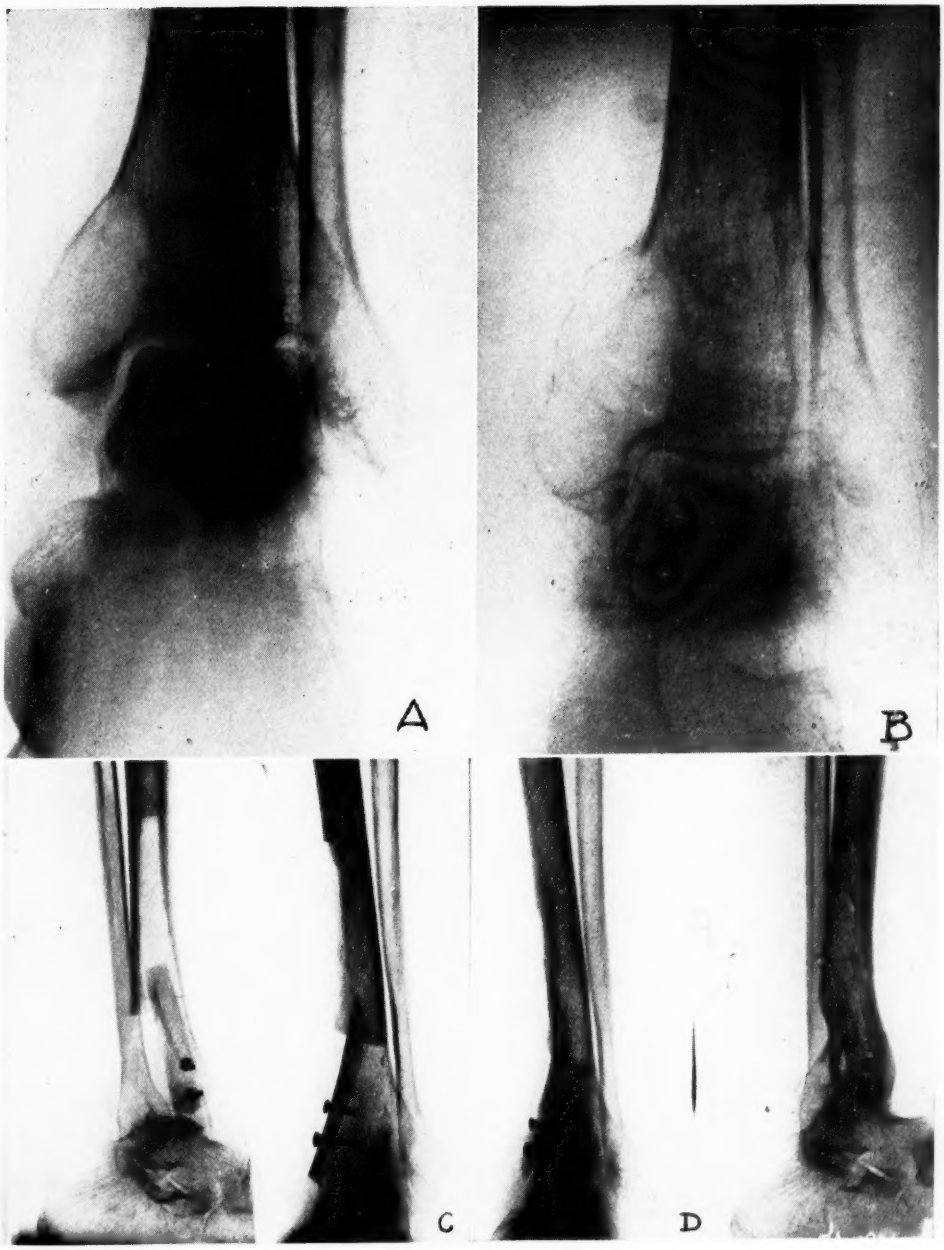


Fig. 1.

pain in his right leg which was attributed to "flat feet," while later "inflammation of the bone" was diagnosed and the leg immobilized in a plaster of paris cast. Roentgenograms, made on February 6, 1940, revealed a giant cell tumor (fig. 1 A).

On February 11, curettage was performed in another hospital and the leg was again placed in a plaster of paris cast up to July. In the meantime the growth became bigger (fig. 1 B). In August, the operative wound opened and secretion and blood escaped.

STATE ON ADMISSION—The medial malleolus of the right leg showed a bulging bone tumor, covered with oedematous skin with ulcerations over an area of 3 by 4 cm. It was ascertained by roentgenographic examination that since the first operation (curettage) the tumor had grown considerably.

On September 8, an operation was performed under spinal anesthesia and the ulcerated part of the skin excised. After having changed the instruments, we then proceeded to the bone operation, consisting in excision of the malleolus far into the healthy tissue. The resulting defect of the tibia was rather large and the tibiotarsal joint thus deprived of its support.

A graft was therefore taken from the part of the tibia adjoining the operative area and pushed downward in a place similar to the normal malleolus. The upper portion of this sliding graft was firmly screwed to the tibia. This newly created malleolar fork will steady the foot, although there is still some doubt about the functional result. The joint was then immobilized in a plaster of paris cast at a 90 degree angle (fig. 1 C).

Healing was smooth. Microscopically, a giant cell tumor was diagnosed. The plaster cast was left in place for the duration of three months.

The patient could be followed up continuously until 1945, and roentgenograms showed satisfactory consolidation of the bone with normal callus formation. There has been no recurrence (fig. 1 D). Since 1942 the patient, a locksmith, is fully able to attend to his work.

SUMMARY—The case was that of a giant cell tumor of the internal malleolus in a man of 31. Progress was rapid after curettage, while cure was effected by radical excision with subsequent sliding graft from the tibia, and construction of a malleolar fork.

CASE 2.—Y. B., a girl of 18, was admitted on December 24, 1940.

HISTORY—Four years earlier, she had had a fall when skiing, and had fractured her left upper arm. Roentgenologically, a bone cyst of the humerus was diagnosed and the arm placed in a plaster of paris cast.

After another one and one half years, pain reappeared in the left humerus at the same place where the bone had been fractured. Roentgen-ray treatment relieved the pain. However, half a year after treatment had been completed, pain reappeared once more.

STATE ON ADMISSION—There was swelling in the middle of the upper arm, the swollen area being tender to pressure and percussion, the bone bulging. Roentgenologically, a multilocular cyst exactly in the middle of the humerus was diagnosed.

Operation performed on December 31, 1940, consisted in thorough curettage with opening of all cysts. The limb was then immobilized in a plaster of paris back-splint. Follow-up examination in 1942 showed perfect healing. Since then we have not had any information.

SUMMARY—A bone cyst which continued to be present after fracture and roentgen-ray treatment responded well to curettage.

CASE 3.—H. J., a man of 21, was admitted on October 10, 1941.

HISTORY—One year earlier he had started complaining of pain in his right elbow which was then immobilized in plaster of paris. There was no improvement and pain reappeared. Roentgenograms revealed a giant cell tumor in the distal end of the humerus. The patient had undergone his first operation, allegedly curettage, in another hospital. Histologically, a giant cell tumor was diagnosed and the limb placed in a paster of paris cast for two months.

In June 1941, since the tumor recurred and grew, another operation became necessary, also performed in another hospital, and consisting in another curettage. Since the tumor continued growing, a development that could be followed up roentgenologically, he was admitted to our department in October.

STATE ON ADMISSION—The humerus showed a protrusion just above the elbow which was painful and severely restricted the movements of the joint. (Cf. fig. 2 A.) Operation was performed on November 5, and consisted in radical and extensive resection of the two

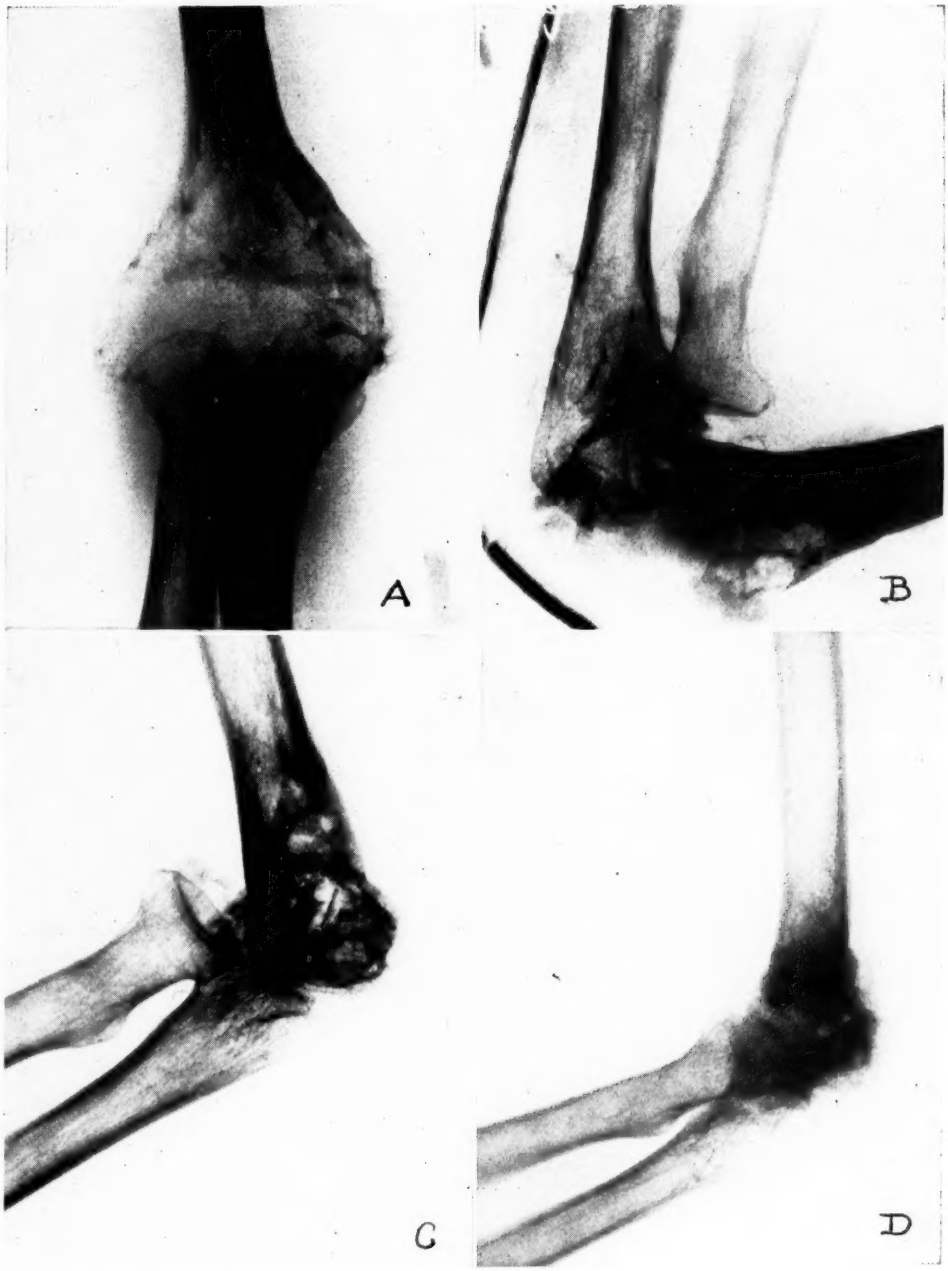


Fig. 2.

condyles of the humerus far into the healthy tissue, the humerus thus being shortened. The stump was given a pointed shape and placed into the cavity formed by the oleocranon, and fascia lata interposed between the stump and the oleocranon. The articular

capsule was gathered in folds by sutures, and the soft tissues shortened (fig. 2 B). Healing in plaster of paris (posterior slab) was smooth. The patient received postoperative roentgen therapy (Prof. Halberstaedter) consisting in application of a total of 1200 r. over two fields. Continuous roentgenologic follow-up showed healing (figs. 2b and 2c). The patient, a car mechanic, is now fully able to attend to his work. Motions of the elbow joint are: 80 degrees flexion and 150 degrees extension. He is not hindered in his work.

SUMMARY—A giant cell tumor of the lower end of the humerus recurred twice in spite of curettage. Resection and plastic operation of the elbow joint produced good functional healing.

CASE 4.—J., a girl of 18, was admitted on October 10, 1941.

HISTORY—Three years earlier she had complained of pain of the major trochanter of the right femur. In the course of the subsequent two years, two biopsies were performed, each one followed by curettage. After the last, she had been free from pain for a full year. Then the old pain reappeared (roentgenograms are not available).

STATE ON ADMISSION—The movements of the right hip joint are unchanged while the major trochanter is tender to pressure and percussion. Roentgenography showed multilocular cystic tumor near the major trochanter which was diagnosed as osteitis fibrosa. Operation performed on May 13, 1942, consisted in thorough excision of the tumor up to the healthy tissue with subsequent reunion of the severed musculature and loose packing of fascia into the bone cavity.

Follow up examination in 1944; the patient has no complaints. Roentgenogram shows healing is complete.

SUMMARY—The excision of a giant cell tumor of the major trochanter after curettage had twice failed, effected cure with healing after excision.

CASE 5.—A. S., a man of 32 years, was admitted on August 18, 1943.

HISTORY—For five years he had been aware of a gradually growing tumor of his left forearm which restricted the movements of his wrist joint. His forearm presented a large bone tumor over which the skin was thinned out with some eczema. There was no pain. The wrist joint was practically immobile (cf. fig. 3A).

Roentgenography is shown in figs. 3B and 3C. His lungs were normal. Operation performed on August 18, consisted in resection of the bone tumor which proved to be sharply outlined without penetration into the soft parts. The bone shell was rather thick and the central part of the tumor contained a dark, sanguinous, fibrous matter. Microscopically the tumor was of a benign type. Microscopic diagnosis: osteitis fibrosa with patches of chronic inflammation, a few giant cells and fibrous bone marrow. The possibility that we were dealing with a sarcoma could not be entirely excluded.

It was intended in a second operation to correct the pathologic luxation of the wrist joint and simultaneously to replace the radius by a bone graft. However, the patient was so satisfied with the result of the first operation that he refused to submit again to surgery. Since he is not working anyway, his hand does not trouble him.

SUMMARY—In a man of 32 years of age, a bone tumor surrounded by a thick bone shell, sharply outlined towards the surrounding tissues and originating from the radius, was removed. To the naked eye the tumor was of a benign nature. Microscopically the diagnosis lay between a giant cell tumor and a giant cell sarcoma.

CASE 6.—J. B., a man 27 years of age, was admitted on March 16, 1943.

HISTORY—On January 15, he had a fall when he was working in the fields and fractured his right upper arm which was subsequently placed in a plaster of paris cast. Roentgenograms revealed a pathological fracture due to the presence of a multilocular bone cyst. A roentgenogram taken on February 17 showed that the fracture was in a good position but that there was not even a trace of callus, and further, that the cystic changes in the humerus had spread.

On March 29, there was still no callus

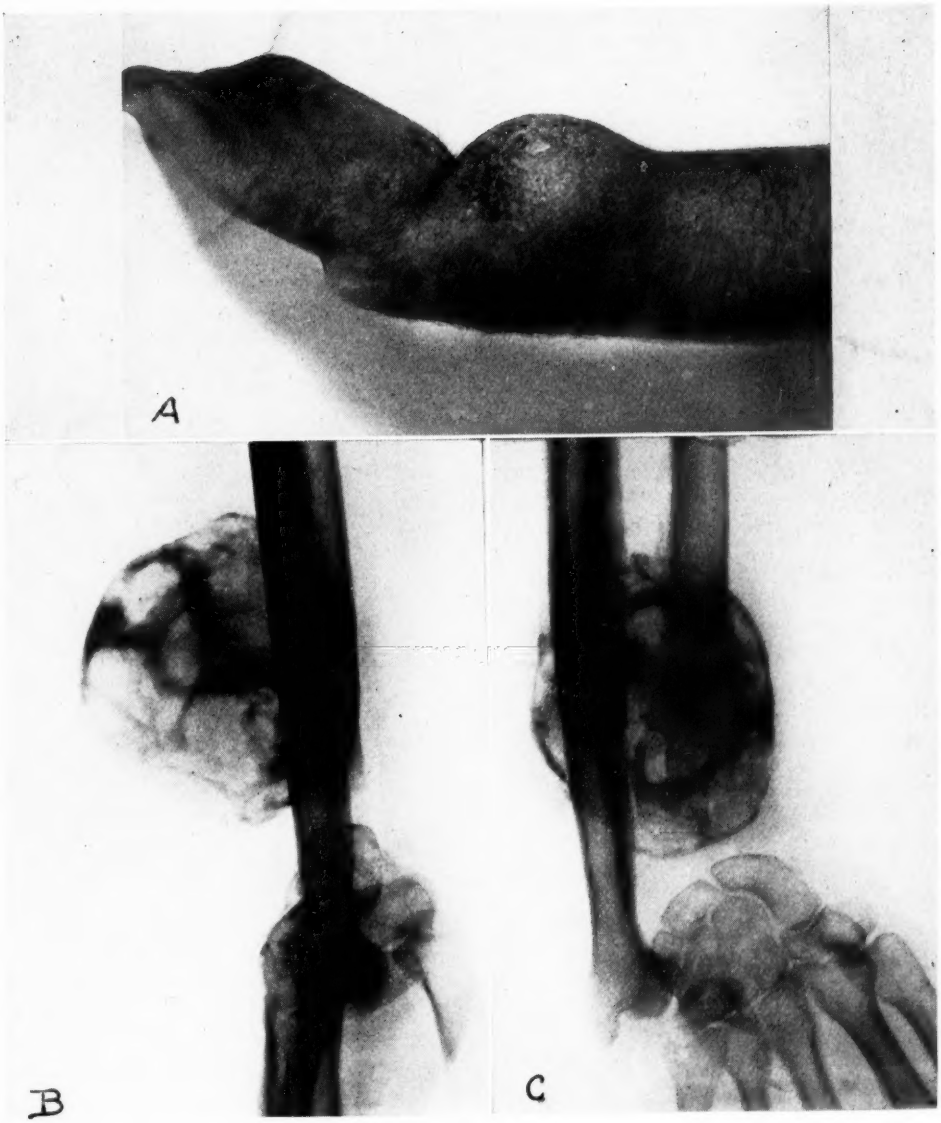


Fig. 3.

formation and no change in the extent of the cyst.

Operation performed on April 2 consisted in thorough curettage of the cyst with opening of all its cells, till achieving hemorrhage from the healthy bone.

Another roentgenogram, taken on August 11, showed callus formation and the cystic changes about to disappear. Follow-up examination; 1945, patient is serving in the armed forces and is in the best of health.

SUMMARY—No healing of a bone cyst was effected by fracture, but took place after thorough curettage.

CASE 7.—A boy, A. J., 18 years of age, presented a spontaneous fracture of his right femur in the trochanteric region extending to the neck of the femur. This he had sustained while playing football. He was admitted on August 14, 1943.

Extension was applied by Kirschner's wire through the condyles of the femur in order to correct the varus position of the neck of the femur, and was continued until October 15. When it was removed, there was not even a trace of callus, and the position of the neck of the femur was only slightly improved.

Operation performed on October 15 consisted in excision and excochleation of the area involved. There was profuse hemorrhage. Since the patient was in rather poor general condition and it was not easy to control bleeding, the planned bone grafting was abandoned and after excochleation and packing of the wound cavity (without which the hemorrhage could not be arrested) the operation was terminated. The limb was immobilized by a spica cast for four months.

Serial roentgenographs taken in 1943, 1944 and 1945 showed complete osseous consolidation of the bone. Although the neck of the femur was still in an abnormal position (coxa vara) completely normal function was restored by 1944. Since 1945 the patient has again been able to play football.

SUMMARY—A giant cell tumor of the trochanteric region and the neck of the femur was not influenced by a fracture. Excochleation was performed but bone grafting was impossible on account of profuse bleeding. Healing was complete.

CASE 8.—A. E. was a man of 23 and was admitted on April 16, 1944.

HISTORY—For some time the patient had been suffering from pain in his left upper arm. A year earlier (1943) he received a kick against his left upper arm which caused a fracture in the lower third of the humerus. Treatment had consisted of a plaster of paris cast. After five months, the patient was able to resume work, but in January 1944, when he undertook gymnastic exercises, he developed another spontaneous fracture at the same place. In another hospital an excision (biopsy?) was performed and he received treatment consisting in immobilization in plaster of paris cast and roentgen therapy (2 fields, 6 times 150 r., altogether 900 r.). No improvement was noted (fig. 4 A).

When he was admitted to our department, extensive osteitis fibrosa was diagnosed (cf. photo.), and resection of the humerus performed with implantation of a 12 cm.-long piece of the left fibula (inlay graft) (April 28, 1944). The histological diagnosis was that of a giant cell tumor. The limb was placed in a plaster of paris cast for six months.

Roentgen controls which were started in October 1944, showed that the bone graft came loose at both ends and the tumor progressed (fig. 4 B). The findings in the lungs, as well as the patient's general condition, were normal.

In a second operation performed on December 24, the old bone graft was removed and after renewed resection of the humerus to healthy tissue, a new graft from the right fibula was inserted (fig. 4 C). The limb was again placed in a plaster of paris cast for four and one-half months. The new bone graft also failed to "take" and melted down (cf. photo.). The result was a rather large bone defect with pseudarthrosis (fig. 4 D).

SUMMARY—The patient presented a giant cell tumor of the left humerus with spontaneous fracture which did not tend to heal. Roentgen therapy also failed, as did repeated resection (twice) of the humerus and bone grafting. A pseudarthrosis developed. The patient's general condition is satisfactory and he is still under observation.

CASE 9.—F. S., a boy of 16 years, was admitted on January 30, 1944.

HISTORY—Four months earlier, he had undergone an operation in another hospital for "Brodie's abscess" of the lateral condyle of the left tibia. For a full month he did well. Later, swelling and pain reappeared at the same place. Roentgenologically, a giant cell tumor of the left lateral condyle of the tibia was diagnosed.

Operation (February 1944) consisted in

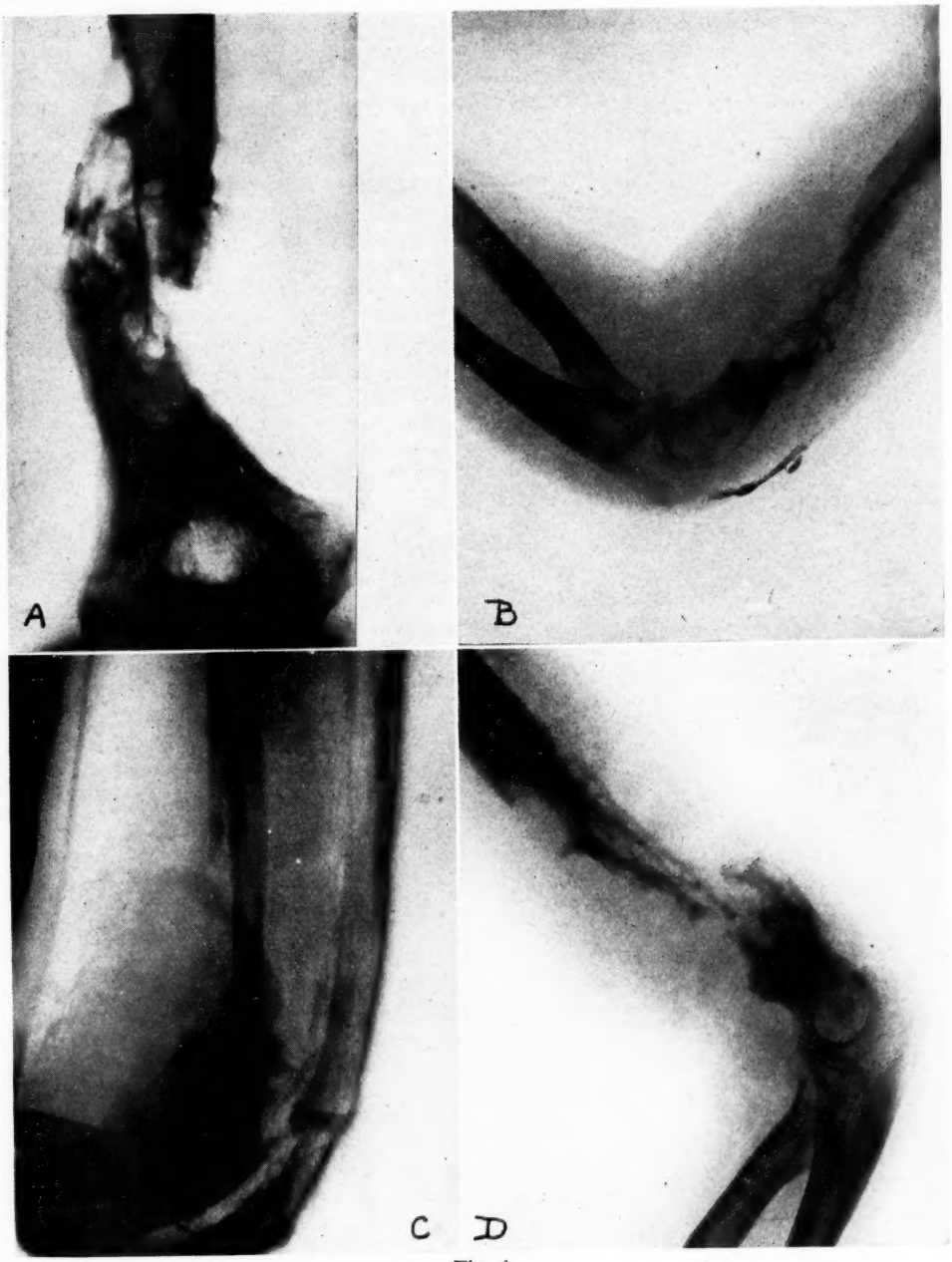


Fig. 4.

very thorough excochleation which was not accompanied by any considerable hemorrhage. The microscopical diagnosis was of a giant cell tumor.

Follow up examination in August 1945 showed, roentgenologically, complete consolidation of the bone lesion. Function was normal.

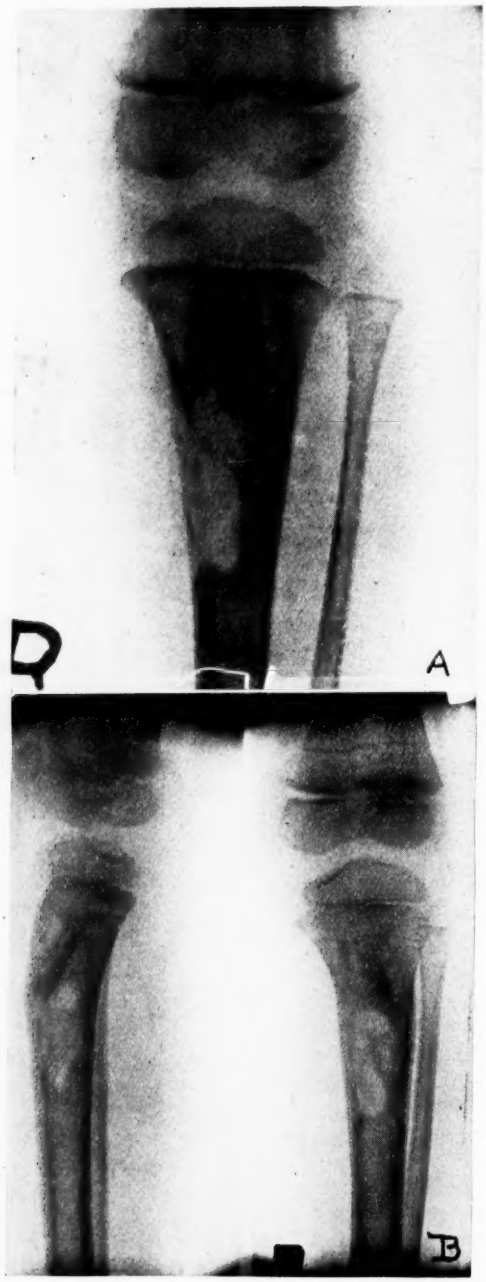


Fig. 5.

SUMMARY—Excochleation of the tibial condyle was performed for Brodie's abscess and a later recurrence was treated by renewed excochleation and complete healing was attained.

CASE 10.—H. M. was a boy of 5. He was admitted on June 10, 1944.

HISTORY—Three months earlier, the child's parents noticed a swelling of the right knee region, and restricted mobility of the knee joint. Roentgenologically, extensive osteitis fibrosa of the head of the tibia was diagnosed (*not* juvenile bone cyst).

Operation, performed on June 12, consisted in radical excision of the capitulum tibiae under preservation of the articular surface. To fill the resulting large cavity, a "sliding graft" was chipped off the exposed metaphysis of the tibia, corresponding in its size to the bone defect of the capitulum, and was pushed into the cavity (fig. 5 A).

The microscopic diagnosis was of a giant cell tumor.

Serial roentgenograms very instructively showed the consolidation of the tibia and the healing of the bone graft (fig. 5 B).

SUMMARY—The case was one of a giant cell tumor in a 5 year old child. Treatment consisted in excision with subsequent implantation of a sliding graft from the tibia. Healing was complete.

CASE 11.—A woman, E., aged 38, was admitted on March 14, 1944.

HISTORY—Since 1941 she had complained of pain in her right knee joint. In 1942, "biopsy" was performed elsewhere and the result, so she told us, was "osteitis fibrosa." She then received roentgen therapy: 1. Four series in February and March, 1942, when she received a total dose of 2,000 r. on two fields; 2. in July 1943 a total dose of 2,400 r. on three fields. After the treatment she felt improved.

For the last six months, she had again had pain, could not walk with comfort, and noticed increasing swelling of the knee joint.

STATE ON ADMISSION—Roentgenograms revealed typical osteitis fibrosa of the head of the tibia.

Operation was performed on March 14, 1944. It was planned to excise the affected tissues and fill the wound cavity by a sliding graft from the tibia. However, the excision of the bone tumor was accompanied by such a considerable hemorrhage that the idea of bone grafting had to be abandoned and, very much against our better judgment, the bone cavity had to be packed. The microscopic diagnosis was of a giant cell tumor. Recovery was delayed owing to infection caused by the packing of the wound cavity. However, in the course of a year, consolidation was achieved. In the meantime, the patient was given roentgen therapy (Prof. Halberstaedter) consisting in a total dose of 2,250 r. on four fields. Even today (August 1945) there is a small fistula. The roentgenologic findings are satisfactory. The patient is still under observation.

SUMMARY—The case was one of a giant cell tumor which did not respond to curettage followed by roentgen-ray treatment. On account of profuse bleeding, an extensive operation was impossible and a fistula developed after packing of the wound cavity. The patient's condition is satisfactory, but observation is still necessary.

CASE 12.—N. B., age 31, was admitted on May 17, 1944.

HISTORY—After she had sustained a slight trauma in the region of her left knee joint, she had had pain for a full year. For the past two months the knee joint region was swollen. The roentgenological diagnosis was of a giant cell tumor of the head of the left tibia.

Operation, performed on May 17, 1944, consisted in excision of the tumor of the head of the tibia up to the healthy neighborhood. During the operation the picture was that of a typical giant cell tumor. The large bone cavity was filled by a sliding graft taken from the tibia in close proximity to the tumor (fig. 6A). The limb was then placed in a plaster of paris cast and roentgen therapy followed (Prof. Halberstaedter). The total dose was 1,000 r. distributed over two months on three fields. Roentgen controls made in 1944 and 1945 showed rapid consolidation of the bone cavity and satisfactory healing of the bone graft (figs. 6 B and 6 C). In August 1944, the patient could be discharged with no complaints.

SUMMARY—A giant cell tumor of the head of the tibia was excised with subsequent insertion of a sliding graft and satisfactroy healing.

CASE 13.—H. Z., a boy 16 years of age, was admitted on July 11, 1945.

HISTORY—For six months he had had pain in the region of the left fibula particularly at night.

A roentgenogram (the patient could not be brought to give his consent to operation) (figs. 7 A and 7 B) showed enormous growth of the tumor, which had developed in a period of 19 days.

Operation, performed on July 19, 1945, consisted in resection of the head of the fibula extending far into the healthy tissue. The microscopic diagnosis was of a giant cell tumor.

SUMMARY—The case presented a very rapidly growing giant cell tumor of the head of the fibula in a boy of 16. Operation consisted in resection.

CASE 14.—A 19 year old girl, E. M., who was admitted on June 27, 1945.

HISTORY—For a few weeks she had had drawing and radiating pain in her right hip. Roentgenographically, there was a multilocular, sharply outlined tumor of the left transverse process of the fourth lumbar vertebra.

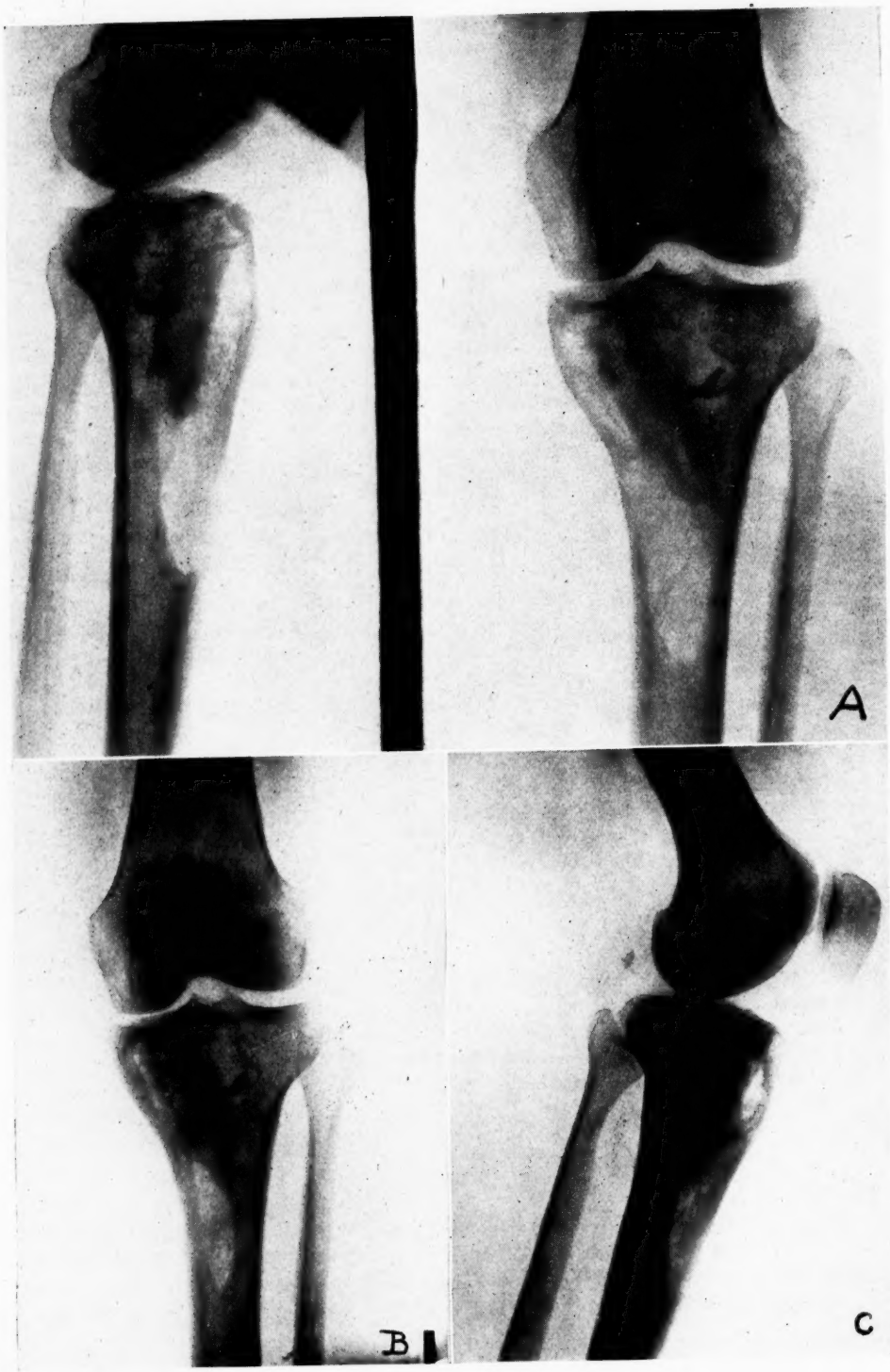
Operation (June 27, 1945) consisted in excision of the transverse process and curettage of its base.

CASE 15.—M. S., a boy 10 years of age, showed in January 1945, a spontaneous fracture of the base of the right radius.

HISTORY—The roentgenologic diagnosis was of a giant cell tumor (no cyst) (fig. 8 A).

Operation was suggested. The boy's father, a physician, did not, however, give his consent and—*faut de mieux*—the boy had to be given roentgen-ray therapy, in 10 sittings totalling 1,000 r. (Prof Halberstaedter).

Another roentgenogram taken in July, showed that the tumor had grown and that


A
B
C

the fracture had not yet healed (fig. 8 B and C). Operation was again refused.

SUMMARY—A 10 year old boy presented a giant cell tumor of the base of the radius in which neither spontaneous fracture nor roentgen-ray therapy had any effect. The tumor, on the contrary, grew, and operation was suggested but refused.

REVIEW OF OUR OWN MATERIAL

Out of fifteen cases referred to the hospital, fourteen were operated. As to the localization there was nothing of significance. Five of the patients had developed spontaneous fractures, but in none of them was this able to promote healing.

Preliminary therapeutic irradiation was given in six of the cases. The therapeutic effect was *nil* and the patients had to submit to surgery.

In six cases, prior to admission, at least one curettage had been performed. In none of them had it had any effect.

Our therapy consisted in:

(a) Excision or resection with subsequent bone grafting (in three cases with good success (Cases 1, 10, 12), in one case without result (Case 8).
(b) Excision alone (in two cases with good result (Cases 2, 4).
(c) Resection without grafting (Cases 3, 5, 13, 14—four cases with good result, two still under observation).
(d) Thorough excochleation [in three cases with good, in one with doubtful result (Cases 6, 7, 9, 11).]

The reasons why, in these four cases, excochleation or thorough curettage alone, was performed were the following:

Cases 6 and 9, During curettage of the multilocular cyst it was possible to promote bleeding which seemed to ensure good prospects for healing.

Fig. 7.

Cases 7 and 11, The patient's general condition was poor in the first case, and in the second, severe hemorrhage during the operation forbade any major intervention.

Fig. 6.

In three of the four cases, healing seemed to be complete.

Among fourteen cases, in which an operation was performed, the results can

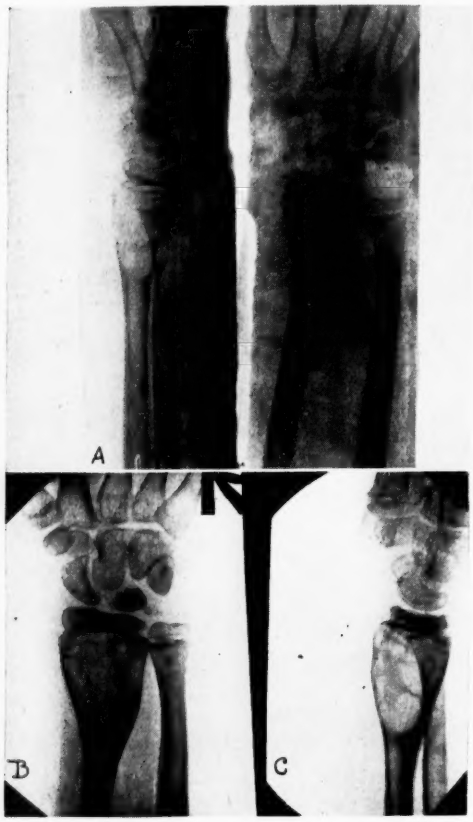


Fig. 8.

be evaluated in twelve (cf. criteria for healing).

One case, in which the operation consisted in resection, remained unimproved and the bone graft was twice absorbed (Case 8).

In one of the cases in which excochleation was performed, healing is not yet complete (Case 11).

Ten cases may be considered as cured after the bone changes have completely disappeared.

Not one amputation was performed!

DISCUSSION

A number of problems arise from the literature, from our former personal experience, and from the recent cases outlined above, which shall at least to some extent, if not thoroughly, be discussed. Only a few of the great number of problems can be dealt with:

(a) *Terminology and the difference between giant cell tumors and bone cysts:*

We believe that the difference stressed in many papers and text books between the two affections cannot be maintained. The distinction between bone cysts and giant cell tumors is artificial in a clinical as well as in a pathogenetic respect.

According to Henderson, retrogression and liquifying of giant cell tumors is possible and leads to the formation of a large cavity filled with serous matter. I have pointed out that at this stage the giant cell tumor is regarded as a bone cyst, although originally it has been called otherwise. A similar viewpoint is held by Geschicter and Copeland, who maintain that "the average solitary bone cyst in the long bones is a healed or healing giant cell tumor."

Watson-Jones writes, "The simplest type of osteitis fibrosa is the solitary bone cyst."

Elmslie points out that a giant cell tumor (or osteoclastoma, as it is called by English authors) may, after curettage, merge into the bone cyst stage.

According to Geschicter, and as it is also generally accepted, bone cysts and giant cell tumors have a common pathogenesis. The difference lies in the tendency of the bone cysts to heal spontaneously, while giant cell tumors tend to develop into progressive bone lesions.

This holds particularly true of the so-called "giant cell variants."

There is, therefore, considerable con-

fusion as regards the question of whether a bone cyst develops from a giant cell tumor or *vice versa!*

Microscopically, bone cysts usually contain giant cell tumor tissue, and I must admit that we have not operated upon one single bone cyst in which this was not the case.

Roentgenographically, a distinction between a bone cyst and a giant cell tumor is only very exceptionally possible, since in solitary cysts, particularly in the multilocular type, recognition of the nature of its contents—whether it is liquid or solid—is impossible. A precondition for the presence of a cyst would be liquid contents. It is, therefore, comprehensible as well as correct when Freund and Meffert refer to the condition under the designation of "cystic lesions of the bone" and not of "bone cysts."

As to the age limit, referred to by many authors, according to whom bone cysts occur under the age of eighteen years, while the giant cell tumors appear later, it must be said that such a distinction cannot be maintained. This is demonstrated not only by our own material (very young patients with typical giant cell tumors and elderly patients with obviously cystic lesions) but also by a case recently reported up by Kleinberg in which a solitary bone cyst persisted unchanged for twenty years without any indication of spontaneous healing, and the patient grew old together with his cyst!

It must, therefore, be concluded that a distinction between bone cysts and giant cell tumors is merely an artificial one in a pathogenetic, roentgenographic and clinical respect—a conclusion which has its therapeutic consequences.

(b) *Spontaneous healing; healing by fracture; roentgen-ray treatment without diagnosis:*

In an affection which may run its course without causing symptoms it is difficult to say that spontaneous healing is impossible. An opinion can only be put forward as regards those cases in which a diagnosis is established owing to fracture or pain or even merely by accident. If, in one of these cases, no treatment is given, any healing may be referred to as spontaneous. We must, however, admit that we have not come across cases of this kind since at least at the moment when the diagnosis is made, some form of therapy (roentgen-rays or surgery) is of necessity instituted. One of the most interesting cases in this category which could be followed up for twenty years without spontaneous healing, is that reported by Kleinberg and mentioned above.

It is again and again stressed in the literature that spontaneous fractures promote the healing in a bone cyst. This conventional view cannot, on the strength of our own experience, be agreed to. We have not seen such an event in any of our cases. On the contrary, Copeland, who has a far greater wealth of material at his disposal, says: "Fracture through the cyst usually results in healing." Photographs which are given to illustrate improvement or healing after fracture are not convincing. Indeed, it would be comprehensible if, in an actually solitary bone cyst, a fracture extending through the entire width of the bone, would provoke adequate bleeding which, in turn, would eventually lead to healing. Such a result is, however, doubtful if the cyst is of a multilocular type or if the fracture consists in a small fissure with no bleeding at all and, consequently, no possibility of healing. It must, therefore, be said that although it is possible that fracture may promote healing in a bone cyst, this is by no means to be presumed with any degree of certainty, as is usually done.

A certain degree of confusion prevails also with reference to roentgen-ray therapy. Geschicter is in favor of it in certain juvenile cases of bone cysts and in elderly patients in whom an operation may not restore the normal weight bearing capacity of the extremity. Roentgen-ray therapy is particularly attacked by William B. Colley (Discussion to B. L. Coley and Higinbotham 1936) who subjects the favorable results of other authors to severe criticism, while Bradley L. Coley and Higinbotham are in favor of either roentgen-ray therapy or surgery: "Either procedure alone gives satisfactory results, whereas a combination is fraught with danger."

As to our own cases it can only be said that in none of them did irradiations preliminary to opertaion have any effect (Prof. Halberstaedter, personal communication).

The main objection to roentgen-ray therapy alone is that it may be given in a bone disease the nature of which is obscure. Cade (quoted by Watson-Jones) and Herendeen suggest instituting roentgen-ray therapy without a definite diagnosis, the latter even believing that biopsy is unnecessary. Such a procedure must be emphatically opposed if it were only for differential diagnostic reasons.

Returning, however, to Coley and Higinbotham's theory that irradiation and surgery are incompatible and may have grave consequences, we should ask ourselves what to do if irradiation has been tried, has failed and we have to proceed to surgery.

(c) *Surgical treatment.*

For diagnostic and safety reasons surgical therapy should be given preference over all other methods.

1. Curettage:

Probably a correct selection of cases and a perfect technic would ensure better results with curettage in giant cell tumors than is actually the case. The technical aspect has especially been studied by B. L. Coley, who laid down certain rules; among others he recommends Esmarch's artificial ischemia, particular thoroughness of the curettage, chemical swabbing of the cavity after the operation with zinc chloride, avoidance of packing of the wound cavity after the operation, accurate closure of the wound, proper splinting and prevention of fracture.

If today a number of authors including ourselves do not deem curettage a very effective method (Albert Key, Inclán, Meyerding, Geschicter and Copeland), after which recurrences are frequent, this must have its special reasons. First of all, in a number of cases, curettage is not, as a rule, very thorough, the bone being opened and the tissue only scraped away by a sharp spoon. Thus certainly much of the pathological tissue is left and where the removal does not extend far into the healthy tissue, healing does not occur.

If, however, the lesion is scraped away as a whole, this may really be called an excision and the wound cavity will have to be filled and consolidated by bone grafts (cf. below).

It may also occur that after opening of the bone there may be such severe hemorrhage (which is not prevented by artificial ischemia either) that the radicality of the operation is interfered with. We have repeatedly encountered such angiocavernous components in giant cell tumors (cf. Cases No. 7 and 11). The hemorrhage here is only stopped by compression and Coley is right when warning against such a procedure without, however, suggesting in what way bleeding should otherwise be controlled. We are thus confronted with the necessity (although fully realizing the conse-

quences) of committing a mistake and packing the wound—a procedure which may lead to secondary infection and fistulation, especially if the radicality of the operation is not complete and may, therefore, result in recurrences—a point that shall be dealt with later.

If curettage is too extensive it is always fraught with the danger of a later fracture (cf. photo by Freund and Meffert, fig. 5, Case 13).

2. Excision or resection of the lesion with subsequent bone grafting or sliding graft.

By bone grafting, the weight bearing capacity of the extremity is reliably preserved. The principle underlying this operation is first of all the very thoroughness of the removal of the lesion in order to forestall recurrence.

We cannot agree with the opinions advanced by some authors that the bone grafts are usually absorbed. Apart from our own Case 8, this is not borne out by our experience, and we could convince ourselves by means of continuous serial roentgenographs that consolidation of the bone cavity is much more rapidly effected when bone grafts are used. As to the use of bone chips for the filling of the bone cavity we have no experience, but it is possible that their healing is less satisfactory than that of solid bone grafts (Watson-Jones).

The essential point to bear in mind is the incomparably rarer development of recurrence than after curettage. The trend in operative methods as regards giant cell tumors is therefore justly toward a radical procedure consisting in excision or resection with subsequent bone grafting.

As to the method of bone grafting to be employed the usual procedure is that of free transplants from distant parts of the body. Albee was the first to use grafts from the neighborhood of the operative field. In one case, Albee and Juvara (quoted from Steindler) used, after resection of the distal portion of the femur, half of the tibia of the same side which was turned upward. There is further a photograph by Watson-Jones showing a "sliding graft" of the upper end of the humerus, a method which was also devised by Albee.

We have used these sliding grafts in three cases, taking advantage of the fact that, with this method, bone tissues from the very close proximity of the original lesion, are used, so that it does not become necessary to make new wounds and to damage healthy bones. We have not observed any harm to the healthy bone by the taking of a sliding graft and in our cases consolidation was always rapid and complete in the lesion as well as in the new bone defect. There are naturally places where after excision or resection, bone grafting is unnecessary (head of the fibula, transverse processes of the spinal column, occasionally the metaphyses of long tubular bones).

(d) Postoperative roentgen therapy is objected to by Copeland but advocated by Henderson, Phemister and Albee (Halberstaedter). In the majority of our cases irradiation was given after the operation and it appears that the method can be recommended.

(e) It is the object of the surgical treatment to effect healing in the bone lesion which can be demonstrated by serial roentgenographs from which it is also possible to derive information as to the stage of ossification and the reappearance of a normal bone structure.

In our opinion it must be clear, after from six to twelve months, whether or not healing is taking place.

It is self-evident that with advancing

consolidation of the bone, swelling and pain subside and the function is gradually normalized. These are the clinical criteria of healing.

If this improvement is absent, the method has failed or one is dealing with a local recurrence or even with a malignant development.

Among our cases, two (one after curettage, one after resection) failed to heal, the first owing, not to incompleteness of curettage, but to hemorrhage calling for packing of the wound. A secondary infection with subsequent fistulation developed, persisting so far for seventeen months and another operative intervention will have to follow. In the second case, the resection did not extend far enough so that the graft later came loose.

Photographs published by other authors are not very elucidating as regards healing. In our opinion fig. 1, fig. 4 and fig. 6 by Freund and Meffert irrefutably show roentgenologic healing.

If, in the course of a few months after treatment or operation, no healing is noted, the case is usually referred to as local recurrence, although we would propose "persistent lesion" as a more appropriate term. Here another operation has to be performed. It is interesting to note that these are the very cases usually referred to as "malignant giant cell tumors" or are described as malignant degeneration of a primarily benign giant cell tumor.

In an article by Stewart, B. L. Coley and Farrow, seven cases of this type are referred to. A careful analysis of the histories, however, shows that in cases Nos. 1, 2, 3, 4, 5 and 7, neither roentgen-ray therapy nor curettage had been followed by proper healing of the bone lesion, so that amputation had to follow, or the patients succumbed to pulmonary metastases although the original microscopic diagnosis had been of a giant cell tumor. Failure to heal and develop into malignancy, therefore, seem to coincide.

According to Geschicter and Copeland "secondary treatment after unsuccessful curettage or roentgen-ray therapy should be particularly intense with every possible attention to malignant degeneration. However, it must be pointed out that the recognition of malignant degeneration should be placed into the hands of experts in bone pathology."

Everywhere in the literature the danger is being stressed of the local or general malignancy of the giant cell tumors with which failure of the original treatment is fraught. Why should not one, therefore, choose the radical approach from the start, unless there are special contra-indications? If preference were given to excision or resection over curettage, this would certainly stem the increasing number of malignant giant cell tumors.

SUMMARY

Fifteen cases of giant cell tumor are described, in fourteen of which, therapy consisted in operation.

Results were satisfactory in all but two cases, which are still under observation.

The method of excision or resection with subsequent free or sliding bone grafts is given preference over curettage, since in the light of our own experience, as well as of references in the literature, local recurrence and actual malignant degeneration and metastatizing of giant cell tumors occurs in an increasing measure.

As regards roentgen-ray therapy preliminary to operation, we were unable to note either a beneficial or a harmful effect. Postoperative roentgen-ray

(Continued on page 162)

Principles of Cineplastic Operations

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As this issue is dedicated to the memory of Fred H. Albee, whose name is so closely connected with rehabilitation work, this is perhaps the place to advocate a method which has gone a long way toward rehabilitating those who have lost one or both hands: the cineplastic transformation of arm stumps. Albee repeatedly expressed his great interest in this procedure, although he never tried it himself.

In a monograph, published in 1942, Dr. Rudolf Nissen and I attempted to give a detailed description of the procedure, so that there is no need again to go into detail. Instead, only a few pertinent points are here brought out.

The idea underlying cinetization is to arrange the stump muscles in such a way that their action can serve to move an artificial hand actively, voluntarily, and in a manner approaching the function of the natural limb. This objective is accomplished by forming a skin tube from a pedicle flap, passing this tube through a tunnel which is bored in the muscle, and fastening the tube to the opposite skin edge. Later, when the muscle, thus canalized, contracts, the skin tube moves with the muscle. This movement is transmitted to the artificial hand by certain mechanical devices.

To be sure, considerable preparatory work was necessary before this simple principle became a reality. The road was strewn with disappointments, before satisfactory results were obtained.

The surgical world has been reluctant to accept this procedure. It may be that many surgeons simply are not familiar with it; others frown upon it for reasons not always easy to follow. Objections have also come from another quarter, the brace makers. Difficulties with regard to prosthetic construction do exist, but they can be, and for that matter have been, overcome.

As to the operation, it is true that, perhaps more than in the average surgical case, the outcome is essentially determined by two factors: proper selection of cases and strict adherence to technical detail.

There can be no doubt that the man who has lost both hands is best suited for cineplastics. As these unfortunates cannot fall back on the one remaining natural hand, practically all of them exercise the required will power and cooperation. In fact, to the man with a bilateral amputation there is no comparable alternative to cinetization.

In bilateral amputation of the upper arm, cinetization according to Sauerbruch's technic is the only method available. With forearm stumps however, instead of doing the canalization on both sides, one side may, perhaps, better be operated on after Krukenberg's procedure. This has the advantage that the patient is able to put on the prosthesis for the canalized side himself, without the help of another person. The same is true of course, if the amputation is at the forearm on one side, and at the upper arm on the other.

For the bilateral cases, the medical authorities of the armed forces seem more or less in agreement with these viewpoints, while in unilateral amputations the policy seems to be to bring the patient back to civilian life as quickly as possible, after he is given an ordinary prosthesis.

Now, in our opinion, based on practical experience, the patients with unilateral amputations too can greatly benefit by this method. However, the indication for cineplastic operation on these patients has to be qualified. It is necessary to analyze with great care the mental background, the physical conditions and the occupational requirements of the patient, so as to be reasonably sure of his attitude and cooperation. Where the incentive is lacking, the natural tendency to make exclusive use of the remaining hand will not be overcome. Such failures serve to discredit the method, and in selecting the cases the surgeons have used poor judgment. Particular caution is called for in right-handed persons who have lost the left arm, and vice versa.

Aside from general considerations in selecting the subject, there are also the local conditions of the stump to be considered. Stumps shorter than 4 inches (10 cm.) are not suited for cinetization. If a forearm stump is too short, cineplasty is applied to the upper arm, unless one prefers to use the natural movements of the forearm stump directly to activate a prosthesis. If an upper arm stump is unduly short, no attempt at cinetization should be made. To utilize the shoulder muscles for this purpose has been uniformly disappointing.

It may be interjected here that on the lower extremity, with its entirely different requirements, those of weight bearing and stability, the application of cineplasty should not be attempted.

As to the operation itself, perhaps we did not make it sufficiently clear in our monograph that there is no good reason to combine the amputation with the cineplastic procedure. The term "cineplastic amputation" has hardly a foundation in fact. The tendons should first firmly attach themselves to the stump end, before tunneling of the muscle can be done without danger of tearing loose its end. Of course, one could unite the flexor and extensor tendons by sutures, when the amputation is performed. But, as the trend in amputation technic is rightly toward simplicity, this principle should prevail. Moreover, at the time of the amputation, the patient as a rule will not have made up his mind as to what kind of after-care he really wants.

It is desirable to have flexor and extensor canals (double motor), because of their valuable antagonistic action. Both can be made in one sitting. If the local conditions of the stump forbid the forming of a double motor, one might, with some prospect of success, create the flexor canal alone and dispense with the antagonistic action. But, where one cannot have a flexor canal, it is not worth while to form the extensor canal alone.

The canal should be wide and short, as narrow ones are apt to become irritated, and long ones distorted. It is therefore preferable to make the pedicle skin flap oblong instead of square, with the two transverse cuts about 4 cm. and the long side about 5 or 6 cm. The canal runs at right angles to the direction of the muscle fibers, and it is placed as far distally as possible. The nearer it is to the end of the muscle belly, the better will be the lifting excursion. The tunnel is made rather close to the surface of the muscle. It is amazing how little of the muscle substance is necessary over the tube. It should not exceed one third of the thickness of the muscle; it may well be less. When the skin tube is slipped through the tunnel, its own intracutaneous suture line must lie proximally. Thus, when the peg is put

in, it presses upon normal, unscarred skin.

As soon as wound conditions permit, usually two to three weeks after the operation, a plaster mold is made for the construction of the prosthesis. At this juncture the real difficulties may begin. To build such an artificial limb is indeed no simple matter and taxes the skill of the brace maker. A great deal of special, individual work is needed; many fittings and alterations make it cumbersome and unattractive to the average craftsman. Therefore, before the operation is undertaken, a mechanic must be at hand who is able and willing to do this part of the job.

Without going into the details of construction, it may be mentioned here that in upper arm cinetization, instead of the old chain transmission, a rigid connection with adjustable stirrups is now used which connect peg and balance beam.

About the scope of cineplastic operations during and after the present emergency, no predictions can be made. It may, however, be of interest in this connection to recall some figures from the first world war. In 1930 a survey was made in Germany of the number and fate of those who had lost one or both hands. To this end, 17,102 questionnaires were sent out, apparently representing the total number of amputations of the upper extremity. Of these forms, 9,326 were answered. Of these, 9,134 were reports on unilateral amputations and 66 on bilateral. The remaining 126 answers could not be evaluated.

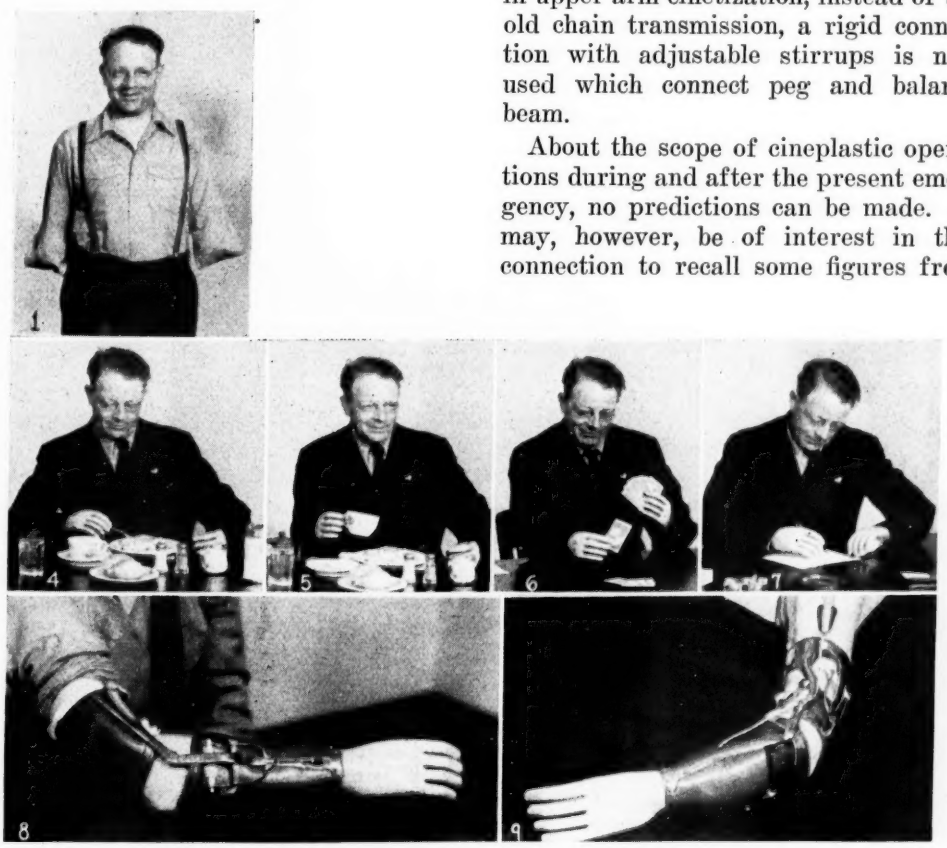

Fig. 1.—Patient with amputation of both arms, showing results from bilateral cinetization.

All in all, 1,485 cineplastic procedures had been carried out. Another German series, studied in 1928, showed that 68 per cent of the cineplastics worked more or less satisfactorily at that time.

Since then, the operative technic has been improved, the construction of prostheses has been simplified, and, perhaps, surgeons' eyes have been sharpened as to proper selection. The results, therefore, should be better.

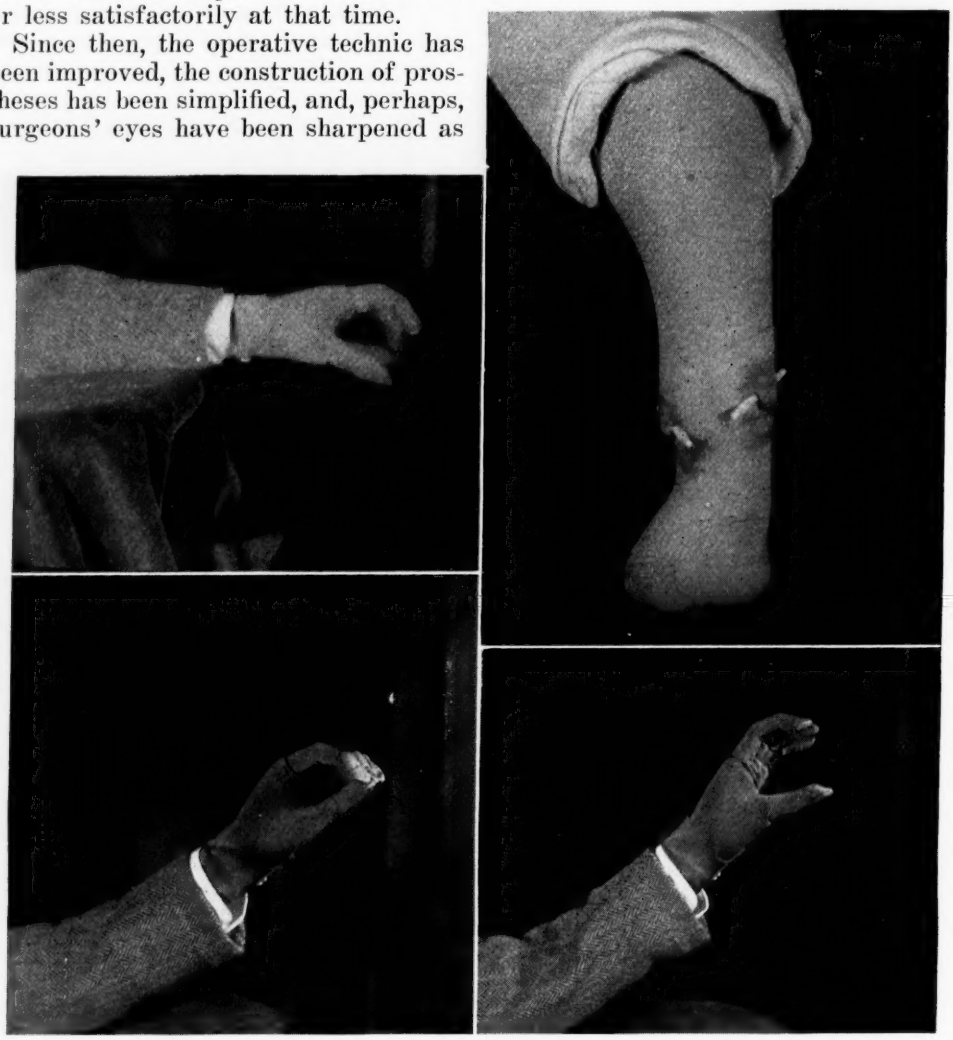

Fig. 2.—Patient with amputation of left arm, showing stump with pegs inserted and range of finger motion.

Since the publication of our monograph, we have operated upon a number of patients, all from civil life. A few details concerning 2 of the cases are appended, as they are of special interest—the first, because it was a bilateral amputation; the second because the cinetization was done eighteen years after the original operation.

The subject of the bilateral amputation was a 36 year old employee of a

midwestern power and light company who had lost both his hands in a pole-top accident in 1941 (fig. 1). The right forearm stump was just long enough to permit cinetization. The left forearm stump was too short, so that the upper arm had to be used. The operations were performed in January and February respectively, of 1943. After an uneventful recovery the patient received his artificial arms in March 1943 and was sent home. In June of the same year the company for which he works sent us a copy of their "Employees' News," containing pictures of him, some of which are here reproduced.

The second man was a 21 year old writer who had lost his hand at the age of 3, also through an electrical accident. He was well informed about the various possibilities and had decided for himself to have a cinetization done. Despite the eighteen year interval and despite the fact that it was the left hand, we felt an attempt at cinetization justified in view of his being so definite about it. The forearm was only about 1 inch (2.5 cm.) long, so that naturally the upper arm had to be used for canalization. The operation was performed in November 1944. A few months later he was able to use the prosthesis to his own satisfaction. The pictures (fig. 2) show the stump with the pegs inserted, and the range of active opening and closing of the fingers.

In conclusion, it may be said that the present operative technic, as well as the construction of the prosthesis, is perhaps not the last word in solving this complicated problem. It should not be difficult, for instance, to improve the appearance of the artificial hand, which still leaves much to be desired. But, on the whole, we are convinced that the work is proceeding along the most promising route yet opened.

SUMMARY

The underlying principles involved in cinetization are summarized. Reasons for the lack of general acceptance of the ideas involved are suggested. The importance of considering carefully all conditions, mental and emotional, as well as physical, is stressed. Reference is made to work of this character done following World War I. Two cases are briefly described.

SOMMAIRE

Les principes fondamentaux de la cinétisation sont énumerés. L'importance de considérer soigneusement toutes les conditions mentales et emotionnelles et physiques est soulignée. L'ouvrage fait après la premiere guerre mondiale est discuté. L'auteur rapporte deux cas brièvement.

RESUMEN

En el presente artículo se resumen los principios inherentes a las operaciones kineplásticas, mencionándose las razones por las cuales el procedimiento no ha sido generalmente aceptado. Se pone de relieve la importancia de valorar cuidadosamente todos los factores tanto mentales y emocionales como físicos. Finalmente, se hace referencia a los trabajos de este tipo llevados a cabo en Alemania después de la primera Guerra Mundial. Se presentan y estudian brevemente dos casos.

Свод

Дан обзор основных принципов кинетизации. Выражены возможные причины, предотвращающие общее принятие этих принципов. Подчеркнута важность принятия в соображение не только физических, но также умственных и эмоциональных факторов. Сделана ссылка на подобную работу в Германии после Первой Мировой войны. Кратко описаны два случая.

Operations on the Bodies of the Vertebrae

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SHORTLY after World War I, I had occasion to study a case of streptococcus viridans sepsis in which one of the lumbar vertebral bodies contained the first visible focus of infection. A small gibbus developed at the involved area, and there was marked local tenderness and muscle spasm. The patient, a girl of eight years, ran a low grade septic temperature. The question arose whether pus was forming, and if so, how the vertebral body could be drained. I could find nothing in the literature to guide me and consequently worked out on the cadaver a simple operative approach. The essentials were a vertical incision just lateral to the erector spinae group, division of the fascia posterior to the quadratus lumborum, blunt dissection of this muscle and of the psoas, so as to create a space between it and the vertebrae, and insertion of a retractor to pull the muscle in a lateral direction. This procedure gave adequate exposure of one half the vertebral body (fig. 1). My septic patient never required the operation because the spinal focus subsided spontaneously, to be followed by numerous other foci, in the pelvic bones, the femora and eventually in the kidneys. All the bone foci regressed without pus formation, but the renal infection eventually proved fatal.

Not long thereafter, Royle and Hunter published their operation for lumbar sympathetic ganglionectomy by the posterior approach. This method differed from mine only in the use of a lateral prolongation of the incision along the iliac crest. Their experience convinced me of the feasibility of operating on the vertebral body in the lumbar region. Later I extended the method to the thoracic and cervical regions.

In 1923, came my first chance to give the operation for vertebral body drainage its first therapeutic test. The patient, a boy of 15, had been brought into the Rockaway Beach Hospital complaining of severe pain of several days duration in the right lower abdominal quadrant. His temperature was 104 degrees. The physical examination showed him to be extremely ill, with septic facies, marked tenderness in the right

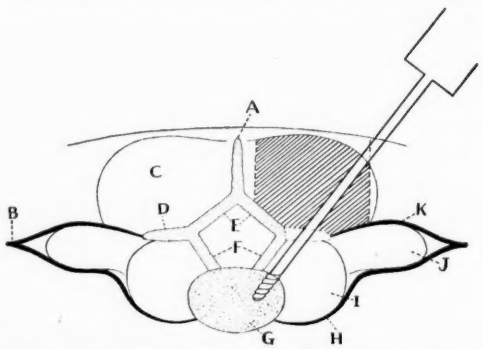

Fig. 1.—Diagrammatic cross section at the level of the first lumbar vertebra, illustrating the principle of approaching the body of the vertebra. (Slightly modified from the original illustration appearing in the Journal of the American Medical Association, March 2, 1918, Vol. 70, Page 594.) The shaded area indicates the mass of the extensor muscles of the spine. These are retracted sufficiently to expose the middle layer of the lumbar fascia (K). After incising the fascia, the quadratus lumborum muscle (J) is exposed. The transverse process may either be resected, or the vertebra approached between the transverse processes by a blunt dissection of the psoas muscle (I) freeing it from the body of the vertebra. A, spinous process; B, lumbar fascia; C, spinal muscles; D, transverse process; E, laminae; F, pedicles; G, body of vertebra; H, anterior layer of lumbar fascia; I, psoas; J, quadratus lumborum; K, middle layer of lumbar fascia.

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iliac region and muscle spasm. The white cell count was high with a heavy preponderance of polymorphonuclears. The diagnosis of the surgical service to which he was admitted, was acute appendicitis and laparotomy was performed as an emergency measure. To the great surprise of the surgeon, a man of considerable experience, the appendix was normal, nor was there the least sign of peritoneal irritation. All the abdominal organs were normal. The following day, when an orthopedic consultation was requested, the boy had a temperature of 106 degrees. He was in a stupor but evidenced a painful reaction when firm pressure was made over the lumbar region. There was slight spasm of the right psoas which prevented extension of the right thigh to an angle greater than 140 degrees. Roentgenograms of the lumbar spine were negative. I hazarded the diagnosis of a psoas abscess secondary to an acute osteomyelitis of one of the lumbar vertebrae. As it was impossible to determine which vertebrae was involved, I made a 6-inch incision running vertically from the first lumbar down to the iliac crest, just lateral to the right erector spinae group. The bodies were exposed in succession beginning with the first, and a drill inserted into each. Nothing was found in the upper four, but as the 5th was exposed, there was a gush of pus coming from an abscess enveloping its body. An opening could be felt in the bone, and as this was enlarged, pus oozed out of the osteomyelitic focus. During the operation, which lasted about 55 minutes, the patient was given saline and blood intravenously. The wound was packed wide open. He made an uneventful recovery with complete healing in two months. The pus culture showed staphylococcus aureus.

Despite the dramatic success of this operation, which naturally whetted my surgical appetite for more of the same kind, ten years passed by before another case presented itself. The patient, a man of about 40, had been ill for almost a year. He complained of vague abdominal pain, more on the left side than on the right, loss of weight, moderate fever and malaise. He had visited the clinics of several excellent metropolitan hospitals and had been admitted to the surgical service of one for several weeks without establishing a diagnosis. His morale had reached a low ebb. My examination showed a fluctuant swelling of the left side of the abdomen, extending from Poupart's ligament upward to the ribs, dullness of the left chest posteriorly from the eighth rib downward, with breath sounds and fremitus absent in this region. The temperature was 102.5. Roentgenograms failed to show any bone focus but evidenced a vague shadow on the left side extending downward from the eighth rib to the pelvis. Aspiration of the abdominal mass gave pus containing staphylococcus aureaus. At operation a huge abscess was opened which measured 12 inches (30 cm.) in length and 6 (15 cm.) in width. It extended along the bodies of the vertebrae posterior to the psoas muscle. It had shoved the left half of the diaphragm upward, thus accounting for the signs of fluid at the base of the left chest. No definite bone focus could be found at the time of the operation. Several months later, however, roentgen-ray studies revealed a slight change in the architecture of the fourth lumbar vertebra suggestive of a chronic osteomyelitis. Since the patient was still running a slight temperature and his wound was still draining, I advised an exploration of the fourth lumbar. To do this effectively, I found it necessary to resect

a portion of the iliac crest, which interfered with the proper exposure of the body. No pus was encountered, but the bone was extremely vascular. A considerable portion of the body was curetted away. This cultured staphylococcus aureus, and microscopically showed changes characteristic of chronic osteomyelitis. Gradually the operative wounds healed, but over a year elapsed before the patient was well. This case, in contrast to the first, illustrated the protracted convalescence in a chronic case, in which the diagnosis had not been made for many months after the onset.

The next case involved one of the cervical vertebrae and called for a modification of the operative technique. A negress about 20 years old was admitted to my service at the Hospital for Joint Diseases. She complained of severe pain in the neck of several months' duration. She had lost weight. There was no definite history of exposure to tuberculosis but this condition was suspected on the basis of roentgenograms which showed a destructive process involving the fifth and sixth cervical vertebrae. The tuberculin test was positive in dilution of 1 to 100,000. On the other hand, the patient was running a septic type of temperature with peaks up to 104 degrees and her blood count showed a leucocytosis. These observations spoke for a pyogenic osteomyelitis. Despite immobilization in a plaster of paris shell, she became worse. Because of the uncertainty of the diagnosis, I felt that an exploration was advisable. A five inch (12.5 cm.) oblique incision was made posterior to the sternocleidomastoid. By blunt dissection, the cleavage line was found between the scalene group anteriorly and the erector spinae group posteriorly. The separating fascia was readily followed down to the tip of the transverse process of the sixth cervical. By running the finger along the anterior surface of the transverse process, the body was easily reached. Pus was encountered. A smear showed tubercle bacilli. The wound was therefore carefully sutured. It healed temporarily, but the patient continued her downhill course and died about a month later. In this instance, I have often questioned the wisdom of my surgical judgment; possibly had I done a fusion of the cervical spine, I might have saved the patient's life.

Fig. 2.—Lateral view of the spine, Case 4, showing the changes in the body of the seventh dorsal vertebra.

Fortunately, the outcome of the next case was more encouraging. My first three patients had had infection; this fourth case was the first neoplasm of the series. The patient was a young woman of 23. She had been admitted as a private patient of Dr. Kestler, to the Hospital for Joint Diseases with a history of pain in the dorsal region of the spine of several months' duration, with radiation to the legs and increasing

difficulty in walking. The roentgenogram showed slight anterior wedging, mottling, and a vertical striation of the seventh dorsal vertebra (fig. 2). There was a paravertebral shadow about 3 inches (7.5 cm.) long which was interpreted by the x-ray department as an abscess. This inclined the roentgenologist to a diagnosis of tuberculosis. The spinal fluid showed total protein of 250 milligrams. On neurological consultation, the favored diagnosis was malignant neoplasm. Dr. Kestler applied a plaster of paris corset and sent the patient home. She was readmitted six weeks later. At that time, I was asked to act as orthopedic consultant. I found that the patient had become worse. She was unable to walk a step, the weakness of both legs was so marked that she could scarcely flex the thighs and dorsiflex the feet. Sensory changes had developed: hypesthesia and hypalgesia of both legs extending downward from the level of the eighth rib to the knees; the calves and feet were almost totally anaesthetic. The knee jerks were exaggerated; also the Achilles reflexes. Roentgenograms did not show any changes other than those previously noted. It seemed to me that the patient was suffering from a neoplasm of the seventh dorsal vertebra which was causing pressure against the cord at that level. The nature of the tumor could not be decided except by exploration. Since this was my first experience with a dorsal vertebra, an additional modification of the operation was necessary. This consisted in a horizontal incision about 5 inches (12.5 cm.) long extending in the direction of the right seventh rib, which met the usual vertical incision near its center. Since I thought that a laminectomy would probably be necessary to relieve pressure against the cord, the vertical incision was placed in the midline. The patient was placed obliquely on her left side, with a tunnel casette beneath the chest. After exposure of the seventh rib about 3 inches (7.5 cm.) from its posterior angle, a control roentgen picture was taken to verify the localization. Then the laminae of the seventh and eighth dorsal vertebrae were exposed by the Hibbs technique. The erector spinae were cut transversely so as to get complete exposure of the lateral process of the seventh and its articulation with the seventh rib. The posterior 3 inches (7.5 cm.) of the rib were resected and a sufficient portion of the lateral process to permit visualization of the body of the seventh dorsal. The laminae of the seventh and eighth were rongeured away to expose the dura. Before opening this, I decided to explore the body. To do this, the posterior portion of the pleura was gently separated from the vertebrae. At one spot, there was a small tear, through which the lung could be seen; a stitch was taken at once to repair the damage. When the vertebral body was well exposed, an additional control roentgen picture was taken with a small drill imbedded in the vertebral cortex. No abscess or other pathology could be found to explain the paravertebral shadow noted on the plate. After roentgenographic verification of the position of the small drill, a larger one was used to bore a hole in the body of the seventh dorsal. As this was withdrawn, a veritable fountain of blood gushed out of the diseased bone. This was controlled by digital pressure which was kept up for several minutes. Then very rapidly the interior of the bone was curetted; the instrument seemed to fall into a hole, so hollow was the vertebra. A packing was inserted into the body, two additional packings were

placed in the posterior mediastinum to wall off the pleura. The dura was not opened. The incision was then closed with particular care to unite the divided erector spinae muscles. After two days, the packings in the posterior mediastinum were removed, and on the 5th day, the bone packing. This latter was done in the operating room in case there should be a hemorrhage from the bone. Fortunately, the precaution was unnecessary. The bone curettings were examined histologically and diagnosed by Dr. Jaffe as an aneurysmal bone cyst. The wound healed satisfactorily, leaving a depression at the site of the emergence of the packings. Three weeks after the operation, the patient stated that she had some sensation in her toes; gradually all the sensory defects disappeared, and muscular strength returned. Six weeks later, she began walking with crutches and within six months she was able to resume her usual work. A year or two later, I did a plastic operation on the scar; by implanting a suitable piece of fat taken from the buttock, the aesthetic defect was completely corrected. There has been no recurrence of the tumor.

From the diagnostic angle, the next case was even more puzzling than the preceding. Mr. M., 62 years old, was seen at the Lenox Hill Hospital in consultation with his physician. He had complained of pain in the upper cervical region for several weeks. Suddenly the pain had become much worse and at the time of his admission was so severe as to require morphine for sedation. When seen by me a few days later, the patient lay in bed with his neck held rigid. The least attempt to move it, actively or passively, produced such intense pain that he cried out. There was local tenderness in the region of the second and third cervical vertebrae. The temperature ranged to 102.5 degrees. Neurological examination showed slight hypesthesia of the right side of the neck corresponding to the distribution of the lesser occipital nerve on the right side. The roentgenogram showed an extensive destructive process involving the second cervical vertebra. The body looked as though an explosion had occurred inside of it (fig. 3). From its appearance, a malignant neoplasm seemed the most likely diagnosis. The patient, however, gave a history of tuberculosis and lues, both of which had to be considered as possibilities. An acute osteomyelitis had to be thought of also, particularly because of the temperature and a leucocytosis of 20,000. To clarify the diagnosis and to give cogency to therapy, a biopsy had to be performed. The patient's condition did not, in my opinion, warrant an extensive open operation; consequently I developed a method of reaching the body of the second cervical without incision. This procedure utilized the tip of the transverse process of the second cervical as a guide to reach the body. With the patient placed prone on the operating table, the head supported by a cerebellar rest, a long needle was introduced in the midline at the level of the second cervical spine and a lateral control roentgen picture taken to verify the accuracy of the localization. Next, a similar needle was introduced obliquely from the right side until the tip of the transverse process of the same vertebra was encountered. A second control picture was taken. A third, longer needle was then passed ½ inch (1.25 cm.) anterior to the preceding until the needle struck bone, presumably the body of the second vertebra (fig. 4). A third control picture was taken, which verified the correctness of the localization. A large bore needle was then introduced

Fig. 3.—Lateral view of the cervical spine of Case 5, showing the pathological changes in the body of the second cervical vertebra. Fig. 4.—Control roentgenogram taken during operation on patient 5, showing needle in body of second cervical vertebra. Fig. 5.—Control roentgenogram taken during operation on patient 5, showing curette within body of second cervical vertebra.

alongside the last needle and made to enter the body of the second cervical. After penetrating a hard outer shell, the needle fell into a cavity—evidently the diseased portion of the bone. It was then possible to pass a hand-drill and then a small curette (fig. 5) through the outer shell of bone, and thus remove a biopsy specimen from the diseased portion. The opening in the skin was closed with a single suture. The operation was performed under a light general anesthetic. The patient left the operating room without any evidence of shock. Microscopic examination of the tissue proved it to be a metastatic carcinoma. The patient's head was immobilized in a Calot plaster jacket and he was transferred to the Memorial Hospital for roentgen therapy under the direction of the late Dr. Ewing. Though the operation was undertaken solely for the purpose of exploration, it had a striking therapeutic effect. The patient's pain was markedly diminished, his tempera-

ture fell to 100 degrees, and the leukocytosis diminished to 10,000. Despite this temporary improvement and also despite intensive roentgen therapy, the tumor gradually increased in size, a metastatic lesion developed in the left upper lobe of the lung, and the patient died about four months later.

The final case of the series, like the preceding, was a man in the early sixties, who, following a fall, had developed pain in the lower dorsal region of the spine. Roentgenograms taken two months after the accident showed a slight compression of the ninth dorsal vertebra. This was at first interpreted as a compression fracture but later a generalized mottling of the vertebra became visible in additional roentgen pictures and a tentative diagnosis was made of malignant neoplasm. My own examination of the patient, six months after the onset of symptoms, showed a slight kyphos in the region of the ninth dorsal vertebra. There was moderate tenderness in this region; motions of the spine were restricted; the reflexes were slightly exaggerated, but there was no ankle clonus nor sensory disturbance. Spinal fluid and blood count did not show any abnormality. The roentgenogram evidenced slight compression of the ninth dorsal vertebra and a generalized mottling. Control roentgenograms of the skull and other long bones failed to show any abnormality. In view of the uncertainty of the diagnosis, and the possible beneficial effects of puncture of the involved bone, I advised exploratory operation. This was done exactly as in Case 4 (the bone aneurysm involving the seventh dorsal) with this exception: that, since laminectomy was unnecessary, the entire operation was performed through an oblique incision running parallel to the ninth dorsal rib on the right side. By resecting 3 inches (7.5 cm.) of the rib and a portion of the transverse process, it was possible to get a satisfactory exposure of the lateral portion of the body of the ninth dorsal. Control roentgen pictures were taken both of rib and of the vertebra before a specimen was removed. On opening the bone, the spongiosa was found to be somewhat redder than the normal. There was no increased vascularity. There was no abnormality of the tissues surrounding the vertebra. A diagnosis of myeloma was made which was confirmed by microscopic examination. The patient made an uneventful recovery from the operation; there was primary union of the wound, and he left the hospital three weeks later. This patient is still alive but a fatal termination is to be expected.

SUMMARY

Six cases have been presented, illustrating the feasibility of operations on the vertebral bodies, two located in the lumbar region, two in the dorsal, and two in the cervical. In each instance, the operation was carried out without serious shock to the patient. In two cases of pyogenic infection, recovery ensued. In one case of tuberculosis, and in a case of metastatic carcinoma, there was a fatal termination. Death is to be expected also in a proven myeloma of the ninth dorsal vertebra. In the sixth case, an aneurysmal bone cyst of the seventh dorsal, there was complete recovery as the result of the operation.

RÉSUMÉ

Six cas illustrant des opérations sur les corps vertébraux sont rapportés; deux dans le région lombaire, deux dans la région dorsale et deux dans la région cervicale. Dans aucun des cas, l'operation ne détermina un choc serieux. Dans

deux cas d'infection pyogénique, les malades guérirent. Dans un cas de tuberculose et dans un case de carcinome métastatique, il y eut une terminasion fatale. Dans un cas de myélome de la neuvième vertèbre dorsale, la mort est probable. Dans un cas de kyste anévrismal osseux de la septième certèbre dorsale, la guérison fut complète.

RESUMEN

El autor presenta seis casos que demuestran la posibilidad de llevar a cabo operaciones sobre los cuerpos vertebrales. La localización en éstos seis casos estaba distribuida del siguiente modo: dos en la región lumbar, dos en la región dorsal y dos en la región cérvical. En todos los casos la intervención se realizó sin que se presentara shock grave para el paciente. En dos casos de infección piógena, la recuperación fué el resultado. Otros dos casos, uno de tuberculosis y otro de carcinoma metastásico, fueron tributarios de un desenlace fatal. Este mismo resultado adverso se pronostica para un caso comprobado de mieloma de la novena vertebra dorsal. En el caso restante, un quiste óseo aneurísmico de la séptima vertebra dorsal, se consiguió el restablecimiento completo.

Свод

Даны шесть случаев, иллюстрирующих возможность операции над телом позвонка: два в поясничном, два в спинном и два в шейном хребте. В каждом случае операция не сопровождалась серьезным шоком. В двух случаях гнойной инфекции последовало выздоровление. В одном случае туберкулеза и в одном случае метастазного рака исход был смертельный. Смерть также ожидается в одном доказанном случае миеломы девятого спинного позвонка. В последнем случае, аневризмы костяной кисты седьмого спинного позвонка, последовало полное выздоровление.

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Donations Urgently Needed.—An urgent appeal is being made by a group of wives of American scientists, for warm clothing and shoes—especially for children—and other necessities of life, to be sent directly to individual scientists and their families in areas stricken by war. "A package sent *now* is worth six sent next spring." Write for names and addresses to Grace H. Smith (who is acting as secretary for the group), c/o National Bureau of Standards, indicating the kind and amount of articles you have available. This cry for help from persons so far above the usual "run" of those in need of charity, is too piteous to be ignored!

Osteoid-Osteoma of Cervical Spinous Process

Report of a Case

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IN 1935, H. L. Jaffe published his first observations on a benign osteoblastic tumor, on the basis of which he distinguished a new pathologic entity, naming it osteoid-osteoma. Since that date, this tumor has created a great deal of interest among pathologists, which has encouraged Jaffe to report thirty-five of these tumors at the Annual Meeting of the American Orthopedic Association, in Kansas City, Missouri, on May 7, 1940.

This tumor has been observed more frequently in males than in females, with a definite predilection for young adults or adolescents. The tumor is more commonly found in the bones of the limbs, particularly the lower ones, and is a greater rarity in other parts of the skeleton. The case reported herewith is of interest, as it belongs to the latter group.

The lesion arises in the spongiosa, the cortex of the long bones or immediately beneath the periosteum and as a rule provokes more or less pronounced reactive formation of new atypical bone around it.

The case which came under my own observation was that of a little girl, 11 years old, white, who had been treated in another institution for tuberculosis of the spinal process of the fourth cervical vertebra. She gave a history of a fall, landing in a sitting position, in November 1943. A short spell of dizziness followed the fall. Nothing else was observed until about three months later, when it was noticed that the girl was developing a slight gibbosity of the cervical spine. She was given several treatments without any diagnosis of the condition for a period of eight months. Then a number of roentgenograms were taken and a diagnosis of tuberculosis of the spinal process was made. She was immobilized in a plaster corset, which was changed periodically during the following seven months. The corset did not bring about the anticipated relief and at frequent intervals during this seven month period, analgesics and sleeping tablets were administered.

She came under my observation in February, 1945, approximately one year and three months from the onset of the symptoms. She was a tired-looking girl, fat, with a slight exophthalmos, pale, and immobilized in a large corset from the head to a point below the waistline. She complained of constant pain in the region of the neck, relieved only by analgesics, particularly of the salicylic group. She also complained of inability to raise her arms, because the pain became almost excruciating. She felt occasional weakness in the upper limbs and some degree of instability of gait and difficulty in walking. There was no complaint of numbness.

The corset was removed, whereupon there was a marked forward inclination of the head, with a slight rotation to the right. The posterior aspect of the neck disclosed marked curvature, a little swelling, but no inflammatory reaction. There was extreme sensitiveness to the touch and the mobility of the cervical spinal column was greatly limited. It was noted that the point of maximum pain was in the midline, over the swelling. Roentgenograms were taken (fig. 1), which showed changes in the spinal process of the fourth cervical vertebral

body. The spinal process appeared enlarged, clava-shaped and formed of a radio-translucent area, semilunar in shape, circumscribed by two very dense zones, one posteriorly, the tip of the process, the other anteriorly, much larger and denser, connected with the

Fig. 1.—Roentgenogram showing appearance of lesion upon first examination by author.

rest of the vertebral body, which was of normal appearance.

On the original films, the upper border of the spinous process appears irregular, with some bone proliferation but without any definite demarcation from the surrounding structures.

The results of urinalysis were normal; the Wassermann and Kahn reactions were both negative. The Schilling blood count showed a slight hypochromic anemia; the white cell count was 10,000, with 10 per cent eosinophyls. Sedimentation rate was 33 mm. in the first hour, 64 in the second. Results of Pirquet and Mantoux tests were both negative. The Mantoux test was repeated twice, in different dilutions, and gave constantly negative results.

With all these data, the diagnosis of tuberculosis was ruled out and two hypotheses became possible. The first one, the more probable, was of a tumor; the second, an inflammatory process, a so-called sclerosing type of osteomyelitis. Both these diagnoses were sufficient indications for surgical exploration and excision of the diseased spinous process.

The operation was suggested and accepted by the family, and was performed at the Strangers' Hospital on April 3, 1945 under general anesthesia (ether, nitrous oxide, supplemented by seconal-scophedal).

The approach was through the midline, the soft tissues being separated from the spinous process and laminae by subperiosteal exposure, preserving the muscle attachments. Much bleeding was thus avoided. The laminae of third, fourth and fifth cervical vertebrae were completely exposed, the posterior half of the fourth, formed by laminae and spinous process, freed anteriorly and cut. The depth of the operative field after the spinal canal was opened, was formed by the yellow ligaments, which were darker than usual and bleeding a little. All bleeding points were controlled and the operative wound closed with chromic catgut in the deep layers. The skin was sutured with plain catgut. The operation was very easy and required forty-five minutes. Immobilization was not necessary.

The postoperative period was un-

eventful and the patient was discharged from the hospital eight days after the operation. By the end of April, twenty-seven days after the operation, the patient was entirely free of all complaints, perfectly able to move her head in all directions without discomfort, and to raise her arms and comb her hair, which she had been unable to do since the early stages of her illness (fig. 2).

The microscopic examination of the specimen was done by Dr. Amadeu Fialho. His description is as follows: "The specimen consists of a vertebral spinous process and parts of both laminae. The spinous process appears considerably enlarged, somewhat irregular in shape, and, when split open, discloses a reddish cancellous bone, soft, and with areas of definite, dense, hard, whitish bone. Microscopic examination shows that the normal structure of the spinous process has been almost completely destroyed, being replaced by osteoid tissue in a substratum of highly vascular connective tissue with numerous trabeculae of atypical bone. There are points of calcification in several small areas, and a great number of myeloplaxes can be seen. These lesions are in part circumscribed by bone tissue with slight sclerosis. Diagnosis: osteoid-osteoma" (fig. 3).

The osteoid-osteoma is a benign tumor of bone, frequently misinterpreted by surgeons and pathologists as sclerosing, nonsupperative osteomyelitis, or as a chronic bone abscess. Cultures, both in my case and in those of other investigators, have yielded uniformally negative results. Microscopically inflammatory lesions proper, or inflammatory perifocal reactions have never been observed. In my case, the lesion was still active; nevertheless, no signs of inflammatory lesions were detected. The lesions are sometimes, as in this case, very rich in giant cells in the more active sectors of the tumor, so that it could be interpreted as a peculiar type of giant cell tumor, or as an abortive type, due to the predominant development in the cortical region of the long bones. Against this hypothesis, Jaffe reminds us that even when the osteoid-osteoma does develop in a

Fig. 2.—Postoperative roentgenogram.

spongy bone it remains just the same, a very small lesion with the same characteristics as when it develops in the hard cortex of a long bone.

The roentenologic features of the osteoid-osteoma are very conclusive in differentiation from a giant cell tumor. The giant cell tumor has an increasing tendency to grow, to blow the epiphysis of a long bone larger and larger. The osteoid-osteoma tends to remain a very small lesion, even when it is accompanied by a strong perifocal sclerosing reaction. Besides, the histologic pattern of the giant cell tumor never shows the presence of osteoid tissue or atypical bone trabecullae as in the osteoid-osteoma.

The entity has definite clinical symptoms sufficient to make one well advised to suspect this lesion, as a preoperative diagnosis. Very striking symptoms are the constant, somewhat dull pain, sub-

siding easily after taking analgesics, particularly of the salicylic group; the local sensitiveness upon pressure of the region, and the swelling without true inflammatory reactions.

given after the operation, mainly because the first pathological diagnosis was of a giant cell tumor.) Relief of the symptoms after surgical excision of the diseased substance, is always strik-

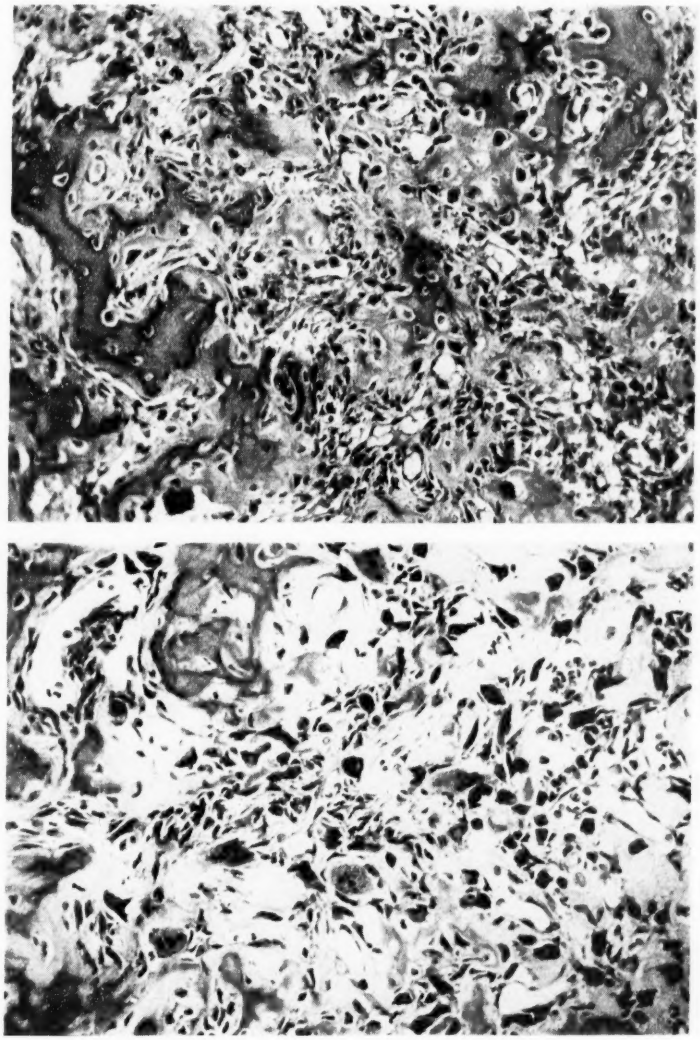

Fig. 3.—Photomicrographs of lesion, author's case.

Treatment should always be operative, though deep roentgen-ray therapy has been recommended. (In my own case, deep roentgen-ray treatments were

ing and no recurrence has ever been observed by Jaffe in his wide experience with this condition.

(Continued on page 129)

Orthopedic Measures for Use in Irreparable Nerve Injury

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IRREPARABLE nerve damage results in loss of sensation and muscle power. Usually the injury causing the nerve lesion has also caused extensive damage to the bones, muscles, blood vessels and skin of the affected extremity. The loss of sensation and paralysis of muscle due to the nerve injury may be of less importance in the total disability than the damage to other soft tissues or to bone. From the time an injury occurs it should be kept in mind that the retention of function in the entire extremity is much more important than the restoration of power in a certain group of muscles, or of sensation in a certain area of skin.

In order to understand and to evaluate the orthopedic measures used in the treatment of irreparable nerve injuries one must acquire the practical viewpoint of the orthopedist. One should be completely realistic, which often means pessimistic. However, any treatment which offers a reasonable chance of improving any disabled patient should be carefully considered, and undertaken if indicated. Rarely can a cripple be completely cured, but almost every one can be improved.

Loss of sensation in the distribution of the median nerve is a major disability, and just as great a handicap as loss of power in the muscles supplied by this nerve. In lesions of other peripheral nerves, however, the patient soon learns to disregard the numbness and often forgets it entirely. Even when the weight bearing area of the foot is completely anesthetic, the patient rarely has serious trophic changes, unless there is an associated deformity such as equinovarus which causes the body weight to be borne upon one small area instead of upon the entire plantar surface of the foot. After complete sciatic paralysis, one might expect to see ulcers on the sole of the foot and Charcot joints, but these are extremely rare. In fact, the difficulties due to malalignment in the lower extremities and deformity in the upper extremities are probably more important than those due to loss of sensation or muscle power.

In the lower extremity, proper alignment of the various weight bearing segments is absolutely essential to both standing and walking. In the attempt to restore normal stance and gait in a patient with a severe injury of the lower extremity, correction of bony deformity and of soft part contracture should take precedence over any nerve repair or muscle transplantation. It is a recognized orthopedic principle that no transplanted muscle can be expected to overcome any fixed deformity. It should also be recognized that the *production* of a deformity in an effort to restore function in a paralyzed nerve, is hard to justify. This is especially true in the lower extremity.

In the upper extremity mobility and muscle power are more important than alignment, but even here the usefulness of the hand depends largely upon the position of the shoulder, elbow and wrist. A normal hand on a wrist fixed in flexion, or on a completely supinated forearm, is much less useful than a partially stiff hand in good position.

In the treatment of fractures, the prolonged immobilization required to ensure solid bony union, promotes fibrosis in

muscles, stiffness in joints and atrophy in bones, even when weight bearing in plaster is allowed. Prolonged immobilization to support paralyzed muscles while awaiting regeneration after nerve suture also promotes fibrosis, not only in the paralyzed muscles but in the normal structures as well. If the chance of success from nerve suture or nerve graft is not good, prolonged splinting of any part, especially in a poor functional position, cannot be justified. Here again, it should be remembered that the extremity as a whole is more important than the partial restoration of power in any group of paralyzed muscles.

It is not possible even to list all of the numerous procedures designed to restore function in paralyzed extremities. Each patient presents a specific problem or even several problems. The final selection of the procedure to be used in any individual case, should be made only when the surgeon has convinced himself that this procedure, or combination of procedures, will more nearly restore normal function than any other. The occupation of the patient as well as his physical and mental make-up should also be taken into consideration.

THE UPPER EXTREMITY

In the upper extremity, operative procedures designed to restore the balance of power between antagonistic muscles, not only reduce the tendency toward deformity, but also produce marked improvement in coördinated muscular activity. Such procedures cannot, however, be expected to correct a deformity or restore completely normal function.

For extensive paralysis, arthrodesing operations not only give more complete and permanent correction of the deformity, but may make additional active muscles available for transplantation to take the place of paralyzed ones. This is especially true in the hand and wrist. If any two of the three major nerves in the upper extremity are permanently paralyzed, wrist fusion is usually indicated. This fixes the wrist in a good functional position and greatly improves the appearance of the hand. It also makes available for use as motors of the fingers any of the wrist flexors or extensors that are still functioning. Arthrodesis of the elbow or shoulder can be performed if the paralysis about either of these joints is so great that the joint cannot be maintained in a good functional position. A clawhand deformity due to section of the median and ulnar nerves at the wrist can be quite effectively overcome by fusion of the interphalangeal joints of one of the fingers.[15] The long flexor muscles will then flex the entire finger at the metacarpophalangeal joint, thus correcting the hyperextension deformity of all the other fingers. Correction of the position of the thumb with fixation of the first metacarpal bone to the second by means of a bone graft, is probably the best method of restoring opposition of the thumb when the median nerve has been destroyed high in the forearm or above the elbow.[33]

After paralysis of a single muscle or group of muscles in the upper extremity, transplantation of an active muscle will often produce remarkable improvement in function.[25, 27] In order to restore active abduction of the shoulder after deltoid paralysis, Ober recommends transplantation of the short head of the biceps and the long head of the triceps to the acromium.[26] Mayer describes a method in which he extends the trapezius downward with a piece of fascia lata so that this muscle can actively abduct the humerus.[22]

In pure axillary nerve paralysis, the remaining active muscles of the shoulder

take over the function of the deltoid muscle so well that operative treatment is often not justified.[11] If there has been extensive paralysis about the shoulder joint, as in lesions of the upper half of the brachial plexus, arthrodesis of the shoulder is usually the operation of choice. Complete loss of flexor power at the elbow is rarely seen, but Steindler's operation of transplanting the origins of the flexors of the wrist and fingers upward on the humerus results in marked improvement (figs. 1 and 2). Even though the elbow joint can be flexed against gravity without operation, this procedure is often justified to increase the power of flexion.[32] It is in the forearm and hand, however, that muscle transplantation gives the most gratifying results.[30]

Because of the winding course of the radial nerve around the shaft of the humerus, and because of the exposed position of its dorsal interosseous branch on the outer side of the elbow, any injury causing a fracture of the shaft of the humerus or an elbow joint fracture, is apt to cause serious and often irreparable damage to this nerve. The sensory loss is of no importance, but the loss of extensor power in the fingers and thumb, if the lesion is below the elbow, or complete wrist drop, if the injury is above the elbow, produces a most unsightly and crippling deformity. In order that the flexor muscles of the fingers and the intrinsic muscles of the hand may perform their many and nicely controlled movements, the wrist must be firmly fixed in dorsiflexion. The loss of this power to fix the wrist and extend the fingers renders the hand almost useless. Although the prognosis for recovery of the radial nerve after injury is fairly good, the time required for regaining motor function is long and recovery is often incomplete. In injuries near the elbow, with extensive scarring about the head of the radius, there is often loss of considerable substance in the dorsal interosseous branch, and recovery of active power in the extensors of the fingers and thumb rarely occurs.

Fortunately, extension of the fingers, thumb, and wrist does not need to be as accurately controlled as do the motions of flexion and opposition. For this reason muscle transplantation for restoration of motor function after irreparable damage to the radial nerve is almost uniformly successful. Some such procedure should be applied early in all cases of gross loss of substance in the radial nerve in which recovery after suture or grafting will be necessarily uncertain or long delayed. A lesion involving the dorsal interosseus branch of the nerve can rarely be repaired by end-to-end suture unless it is a simple laceration seen soon after injury. Because the results of tendon transplantation are so satisfactory, and because function in the extremity can be restored so nearly to normal, tendon transplantation should be performed at once if it has been impossible to obtain a perfect

Fig. 1.—Steindler's Procedure of Transplantation of the Flexor Musles at the Elbow. The common origin of the flexor muscles from the internal epicondyle is freed and transplanted upward on the humerus to restore active flexion of the elbow Fig. 2.—Steindler's Procedure of Transplantation of the Flexor Muscles. After flexor muscles of the wrist and fingers have been transplanted proximally on the humerus they act as strong flexors of the elbow as well as flexors of the wrist and fingers. Fig. 3.—Transplantation of the Forearm Flexors to the Extensors of the Fingers and Thumb for Radial Nerve Paralysis. The strong flexor carpi radialis and flexor carpi ulnaris muscles are freely mobilized through incisions on the flexor surface of the forearm. Fig. 4.—Transplantation of the Forearm Flexors to the Extensors. The flexor carpi radialis is inserted into the extensors of the thumb and into the extensor proprius of the index finger. The flexor carpi ulnaris is inserted through the extensor proprius of the little finger and into the common extensors of the other fingers. Strong extension of the fingers and thumb will result. (If the nerve injury is above the elbow, transplantation of the pronator radii teres into the extensor carpi radialis longus or brevis will provide strong active extension of the wrist.)

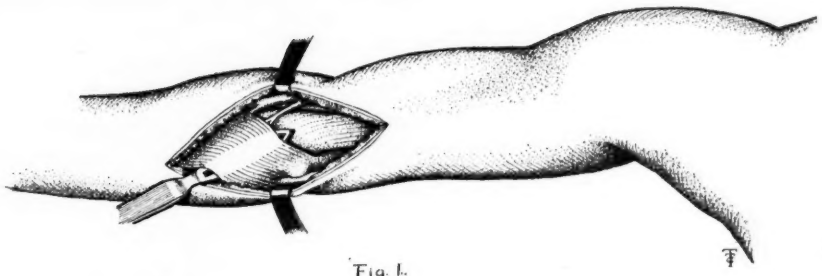
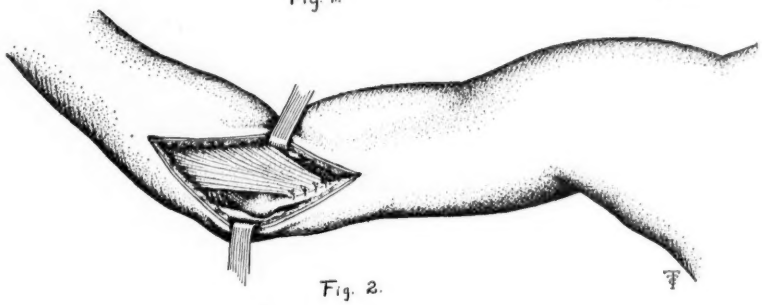


Fig. 1.



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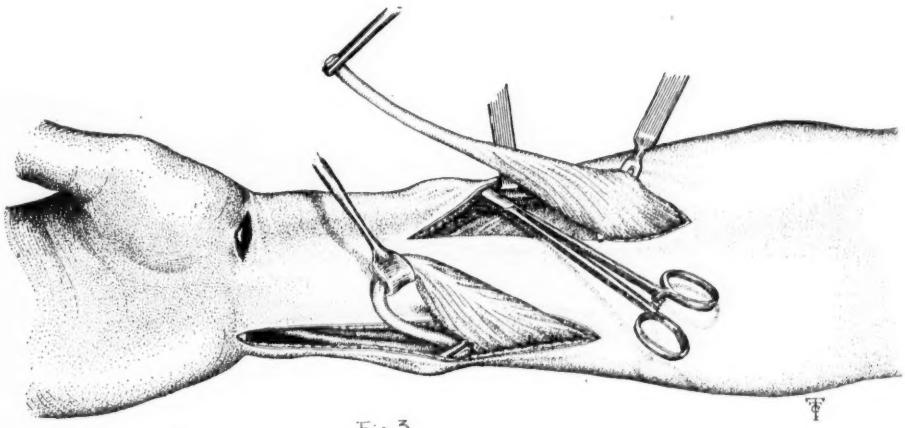

Fig. 3

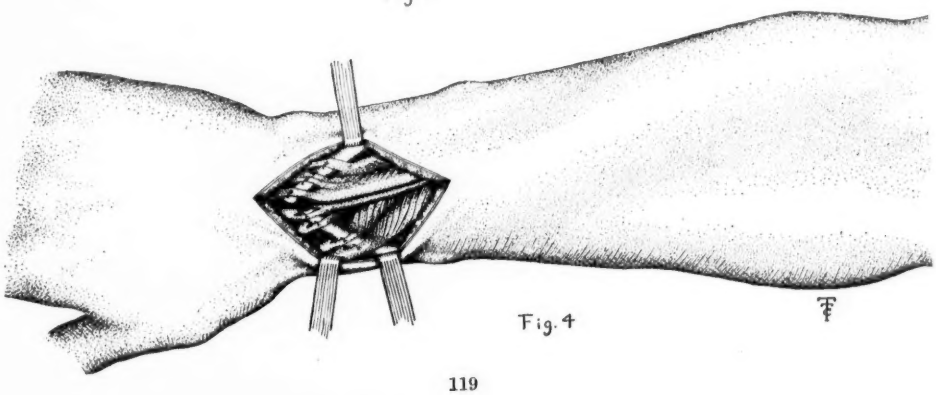

Fig. 4

suture of the nerve in an unscarred field.

The exact type of procedure used does not seem to matter a great deal, as various authors report excellent results with different techniques. The transplanted muscles should be strong enough to hold the wrist and fingers in extension without tiring. The palmaris longus is often weak or may be missing. For this reason it is unwise to count upon it to provide strong extension of any finger or the thumb. The flexor carpi radialis and flexor carpi ulnaris are strong muscles which can be freely mobilized without disturbing their nerve and blood supplies. They can be brought around the radial and ulnar sides of the forearm respectively to provide strong extension of the fingers and thumb (fig. 3). The palmaris longus is left intact to provide flexion of the wrist. Occasionally after muscle transplantation, function returns in a radial nerve that had been considered permanently paralyzed. This usually results in hyperextension deformity of the wrist with the fingers flexed. It is then necessary to replace the transplanted flexor muscles in order to restore muscle balance. As this is not unduly difficult, the remote possibility of such spontaneous recovery is not a valid reason for delaying the transplantation of the flexors into the extensors.

It should be noted that normally the thumb and index finger function together. When the thumb rotates and flexes in the position of opposition, the index finger flexes to meet it. When the hand is spread out, the thumb and index finger extend simultaneously. For this reason, it seems advisable to use the flexor carpi radialis to provide extension of both the thumb and index finger as well as abduction of the thumb, by threading it through the abductor pollicis longus, the extensor pollicis brevis, the extensor pollicis longus, and the extensor indicis proprius. The other fingers usually flex together in the position of grasp or are extended simultaneously when the hand is spread. For this reason the flexor carpi ulnaris is transplanted into the common extensors of the fingers and the extensor digiti quinti proprius (fig. 4). If the nerve injury has been below the elbow, the extensor carpi radialis longus will be still functioning and there will be adequate power to dorsiflex the wrist. When the damage has been above the elbow, the lost power of dorsiflexion of the wrist can be restored by freeing the pronator radii teres from its insertion into the radius and threading it into the extensors carpi radialis longus and brevis.[16, 36] It has been my practice, when the radial serve loss was complete, to supplement the transplant of the two flexors of the wrist by transplantation of the pronator radii teres into the radial extensors, but this may be unnecessary. If the radial nerve paralysis has persisted for some time, there often is a pronation deformity as well as a wrist drop. Transplantation of the pronator radii teres will not only reenforce the paralyzed wrist extensors, but its removal from the radius may correct a pronation deformity.

Although loss of ulnar nerve function produces a characteristic deformity, it does not represent a major disability. Many soldiers with complete ulnar nerve paralysis can perform full duty. A partial lesion of the ulnar nerve may, however, cause so much pain in the ulnar distribution that the patient protects the entire extremity and uses it only when forced to do so. If, after transplantation of the ulnar nerve to the front of the elbow, or neurolysis, or nerve graft, the patient still has pares-

thesia and dysesthesia in the ulnar distribution, he will not use the extremity and will have a much greater handicap than a person with a complete ulnar lesion. In some instances, where there has been extensive soft part damage and the nerve lies embedded in a mass of scar tissue, the prognosis for restoration of ulnar nerve function is so poor that it is justifiable deliberately to section the nerve well above the site of injury. This simple procedure, which is so satisfactory in relieving pain when any purely sensory nerve is hopelessly involved in scar tissue, should be kept in mind in the treatment of partial lesions of the larger nerves. After severance of this nerve, especially if it has occurred in childhood, accommodation to the absence of sensation in the little finger and to lack of power in some of the intrinsic muscles of the hand may be so complete that the loss of ulnar function is scarcely noticed. Prolonged hospitalization and complicated surgical procedures of doubtful value are scarcely justified. It is much more important to convince the patient that his handicap is a minor one, and induce him to engage in some useful occupation in which he can learn to compensate for his loss of ulnar function, rather than concentrate upon it. Although some orthopedic operations have been designed for pure ulnar nerve paralysis, their use is rarely justified unless there has been damage to the median nerve and flexor tendons as well.

Because of loss of sensation and power in the thumb and index finger, irreparable damage to the median nerve renders the hand, and with it the entire upper extremity, almost useless. If the ulnar nerve has been spared, considerable useful function can be reestablished. One should not, however, expect much functional improvement if attempts to restore sensation in the median distribution have failed. A clawhand deformity of greater or lesser degree develops following and median or ulnar nerve lesion. In combined median and ulnar lesions, it is most unsightly and completely disabling. If the injury has been low enough to spare the innervation of the flexor muscles in the forearm, the most satisfactory way of overcoming the deformity is to use the sublimis tendons to substitute for the paralyzed lumbricales and interossei.[3, 4, 5, 6, 7] The sublimis tendons can be sectioned near their insertions, brought out through a palmar incision, and threaded down through the lumbrical canals. The tendons can be split well up into the palm so that eight slips of tendons are available for reinsertion into the extensor aponeuroses of the fingers (fig. 5). These tendons in their altered courses, will no longer flex the middle phalanx on the proximal one, but will produce flexion at the metacarpophalangeal joints and extension of the distal phalanges. It is sometimes possible to arrange the insertions so that a certain amount of adduction and abduction of the individual fingers is also accomplished. For injuries of the individual branches of the ulnar and median nerves appropriate muscle transplantations have been devised.

One of the most important functions of the hand is opposition of the thumb to the fingers. Numerous complicated procedures have been described to restore this function.[2, 14, 24, 28, 29, 31] The use of a graft between the first and second metacarpal shafts has been mentioned above.[33] Simple posterior dislocation of the base of the first metacarpal, puts the thumb in a position of moderate opposition and has been recommended as a method of treatment.[10] The author's modification of Royle's operation, in which the flexor

sublimis tendon of the middle or ring finger is brought out through the palm and run subcutaneously across the thenar eminence, is one of the simplest methods and restores almost normal opposition if the transplanted muscle is two parts of a pinching action, little or no reëducation of the transplanted muscle is needed (figs. 6, 7).

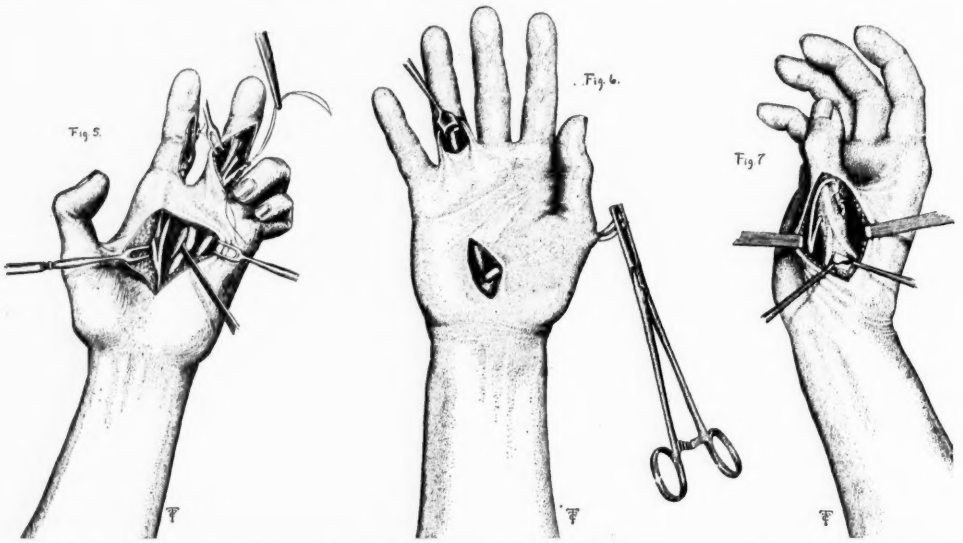

Fig. 5.—Transplantation of the Flexor Digitorum Sublimis Tendons for Clawhand Deformity. Following median or ulnar paralysis, the transplantation of flexor digitorum sublimis tendons through the lumbrical canals into the extensor expansions will, in a large measure, restore active flexion of the metacarpophalangeal joints. Fig. 6.—Transplantation of a Flexor Sublimis Tendon into the Thumb to Restore the Power of Opposition. In the author's modification of Royle's operation, the flexor sublimis tendon to the ring or middle finger is sectioned at the base of the finger and brought out through a palmar incision. The distal margin of the transverse carpal ligament acts as an excellent pulley for the transplanted tendon as it runs subcutaneously across the thenar eminence. Fig. 7.—Transplantation of a Flexor Sublimis Tendon into the Thumb to Restore the Power of Opposition. The thumb is first rotated into a position of full opposition. (An osteotomy at the base of the first metacarpal bone is performed if necessary.) Good active opposition is then maintained by threading one segment of the transplanted sublimis tendon through a hole in the distal end of the metacarpal and the other through a subperiosteal tunnel at the base of the first phalanx.

THE LOWER EXTREMITY

In the lower extremities orthopedic procedures are directed primarily toward correction of deformity. Elimination of muscle imbalance which causes deformity is next in importance. Occasionally it is possible actually to improve muscle function, eliminate a limp, and increase endurance. A person can walk quite well on a completely paralyzed extremity or upon an artificial leg. It is only necessary to be able to lock the parts in a good weight bearing position. The extensors of the hip and knee and strong enough and all fixed deformity has been corrected.[34] The lower border of the transverse carpal ligament forms a smooth pulley for the transplanted tendon, which is split and inserted into the distal end of the first metacarpal bone and the base of the proximal phalanx of the thumb, so that it runs in the same direction as the fibers of the paralyzed opponens pollicis. Since opposition of the thumb and flexion of the fingers normally take place together as

the flexors of the foot and ankle aid greatly in accomplishing this. Muscle transplantation to reinforce these muscle groups should be considered, but rarely are muscles available with strength great enough to justify their transfer. In paralysis of the quadriceps one or more of the hamstrings may be transplanted forward. The improvement which results is usually due to correction of the slight flexion contracture of the knee which has developed as a result of shortening of the unopposed hamstring muscles.

When attempting to restore function in the lower extremity the foot should be considered first. It is a stable pedestal during stance and a strong lever when walking.

Pain in the foot or referred to the foot, which is usually aggravated by weight bearing, represents a major disability. Contracted tendons or muscles, especially if adherent to nerves, may cause severe pain on walking. Radical excision of scarred muscle, lengthening of contracted tendons, and above all, freeing of nerves from scar tissue in the foot and leg should be undertaken whenever an injured extremity remains painful. If there is intraneural scarring, or if the nerve must be replaced into a scarred bed, high section of the nerve often results in more functional improvement than neurolysis or nerve suture. A painful partial lesion is much more disabling than a complete lesion. In purely sensory nerves, especially in the lower extremity, section of the nerve above the scarred area is almost always preferable to nerve suture. Even in the larger nerves, section should be performed if it is believed that the injured nerve trunk is apt to remain painful. This requires qualification, however, as section of median or sciatic, would not be a good treatment for causalgia.

After section of the posterior tibial nerve in the calf there is usually a tendency toward cavus deformity of the foot and clawing of the toes. This is rarely severe enough to warrant more than correction of the individual toe deformities by arthrodeses of the interphalangeal joints, capsulotomies, or transplantation of the long flexor muscles into the extensors. In severe claw foot, transplantation of all the extensor tendons into the necks of the metatarsals, accompanied by plantar fasciotomy, may be necessary to flatten the foot and correct the deformities of the toes.

When muscle power has been completely lost below the knee, every effort should be made to produce in the foot a pedestal for standing and a lever for walking.[23] With a well fitted prosthesis an amputee can walk without any appreciable limp. A foot similar to an artificial one can be produced by a carefully planned foot stabilizing procedure. Many different types of bone operations have been designed for paralyzed and deformed feet. The exact type of procedure chosen for the individual case is not important if the following criteria for satisfactory foot stabilization are fulfilled:

(1) The plantar surface of the foot must be smooth and in such a position that the body weight is distributed to its entire area;

(2) There must be a good lateral stability when the foot is placed upon the ground, even though inverting and everting muscles are paralyzed;

(3) The foot must be placed beneath the leg in such a position that the "push-off" from the metatarsal heads is reëstablished;

(4) Ankle joint motion within a limited range should be retained if possible, but good function can be secured, even after ankle fusion, provided the

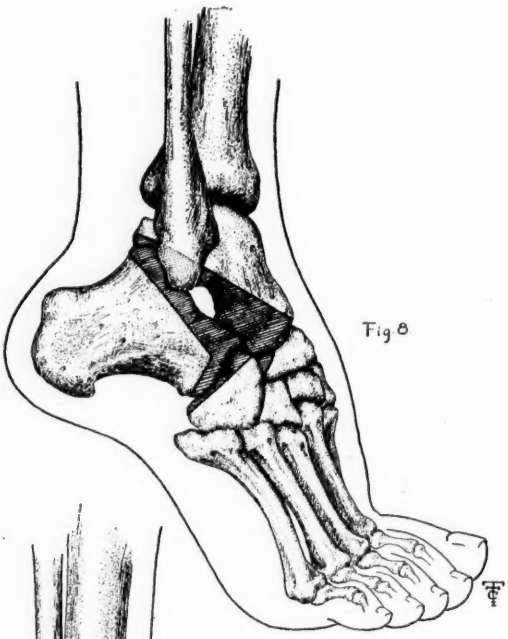

Fig 8

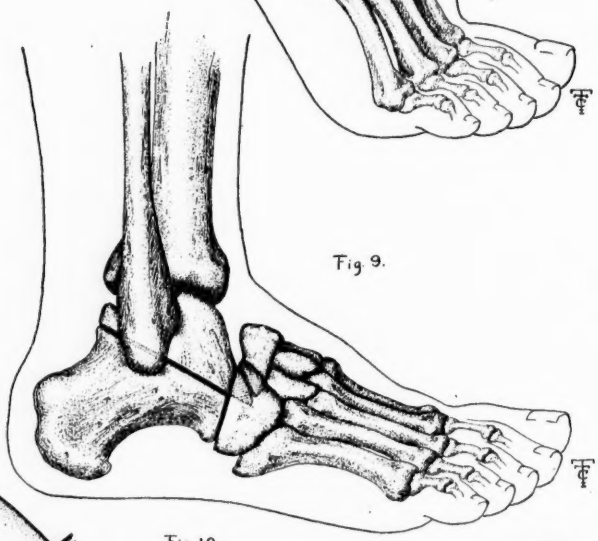

Fig 9.

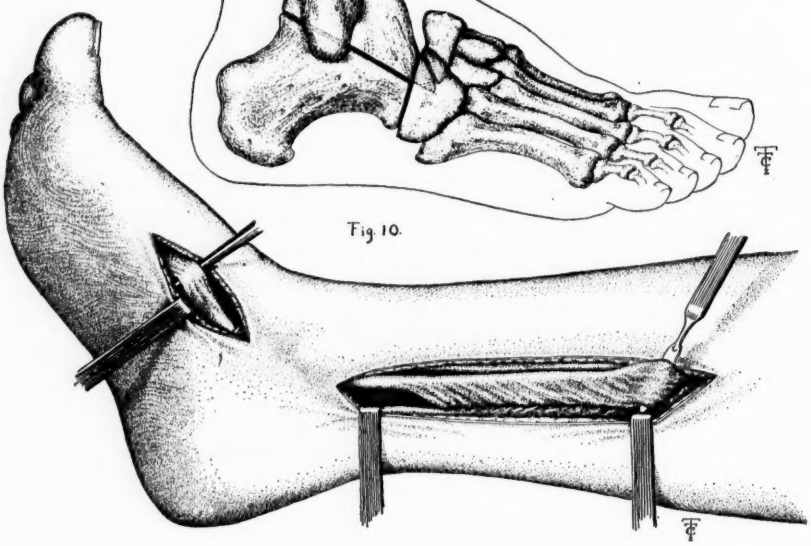

Fig 10.

alignment of the extremity upon the foot is perfect;

(5) The foot should be painless. (Complete anesthesia is better than paresthesia or dysesthesia.)

(6) Supporting braces should be unnecessary.

(7) The foot should fit into an ordinary shoe.

In equinus and equinovarus deformities, following peroneal or complete sciatic nerve paralysis, the Lambrinudi procedure, which involves the removal of appropriate bone wedges in the subastragalar and midtarsal joints, accomplishes correction of the deformity with mathematical precision [17] (figs. 8 and 9). Numerous other types of foot stabilization,[9, 13, 18, 38] posterior bone blocks,[8, 37] tenodeses and tendon transplantations [1, 19, 20, 21] are of proven value and should be used when indicated.

In the lower extremity any direct injury in the region of the knee may produce peroneal nerve paralysis. As the nerve winds around the head of the fibula it is practically subcutaneous and it is even more vulnerable than the radial nerve in the upper extremity. The injury often involves a considerable extent of the nerve, and nerve suture is difficult or impossible.

In the arm, flexion of the elbow may be used to allow end-to-end suture, as this is the usual position of the elbow when the hand is active. In the lower extremity, however, acute flexion of the knee is hardly justified in an effort to obtain a good end-to-end suture, as even slight flexion deformity of the knee entirely upsets the weight bearing function of the leg, producing fatigue when standing and a limp when walking. Furthermore, the results of suture of the peroneal nerve are notoriously poor.

Injuries of the external popliteal nerve are often associated with fractures of the upper end of the fibula or both bones of the leg. Usually the treatment of the fracture requires prolonged immobilization of the leg and foot. In the upper extremity, stiffness of the fingers, hand and wrist causes marked permanent disability and should be avoided even at the risk of insufficient splinting of fractured forearm bones, or inadequate support of paralyzed muscles. In the lower extremity, however, the stiffness that occurs in the foot and the fibrosis in the paralyzed extensor muscles are really an asset in preventing the development of severe equinovarus deformity which is to be expected with complete paralysis of the peroneal nerve. When this type of paralysis occurs in childhood, or when no extensive muscle or bone destruction has been associated with the nerve injury, a marked equinovarus deformity will develop. To overcome this deformity it is necessary to perform an arthrodesing operation in the subastragalar and midtarsal region, which corrects the supination and adduction of the foot and limits downward motion at the ankle. Such an operation, although it does not restore active dorsiflexion, does produce a very satisfactory

Fig. 8.—The Lambrinudi Procedure to Correct Equinus and Varus Deformities. Removal of an appropriate bone wedge through the subastragalar joint corrects the equinus and inversion of the heel. Removal of a wedge of bone through the calcaneocuboid joint corrects adduction of the forefoot and the cavus deformity of the foot. Fig. 9.—End Result of Lambrinudi Type of Subastragalar Arthrodesis. After correction of the deformity by removal of subastragalar and midtarsal bone wedges, the foot is in a stable weight bearing position. As the astragalus remains in equinus, a physiological bone block is established. Recurrence of the deformity is prevented by impingement of the posterior tip of the astragalus against the posterior tip of the tibia. Fig. 10.—Transplantation of the Tibialis Posticus to the Dorsum of the Foot for Equinovarus Deformity. This strong muscle can be used to overcome the varus and equinus deformities which usually follow peroneal nerve paralysis. The muscle is freely mobilized to allow it to function well in its transplanted position.

weight bearing foot, if alignment is perfect.

In adult patients who have had extensive injuries of the leg, it is usually possible to prevent development of equinovarus deformity by immobilization in plaster in good position, followed by constant support in a well designed brace. As soon as it is recognized that the peroneal nerve injury is to be permanent, some operative procedure to eliminate the drop foot brace should be undertaken. After all the extensors and evertors of the foot are paralyzed, the constant pull of the strong, unopposed tibialis posticus is the main cause of the varus deformity. Early transplantation of this muscle will not only prevent development of varus, but will also help overcome the tendency toward equinus. This muscle transplantation can be supplemented by subastragalar and midtarsal arthrodesis, if necessary. The technique of the procedure as used by Major R. Nelson Hatt is as follows[12]:

"A two-inch (5 cm.) incision is made over the middle cuneiform and the dissection is carried down just lateral to the dorsalis pedis vessels. A quarter-inch (.625 cm.) drill hole is made obliquely downward and inward, going through until the point of the drill can be felt at the inner border of the foot, approximately opposite the inferior aspect of the first cuneiform bone. The incision is then closed with a Michel clip. A short curved incision is next made over the insertion of the tibialis posticus muscle. A third incision begins at a point just posterior to the medial malleolus and extends upward approximately 12 to 15 centimeters. The tendon of the tibialis posticus muscle is detached at its insertion and the aponeurotic portion is dissected forward, since without this it is a little short when transposed" (fig. 10). "The tendon is then pulled up through the third incision and the muscle belly stripped upward until the tendon can be swung forward in a straight line with the dorsal incision on the foot. A tunnel is made through the subcutaneous fat by passing a hemostat up from below, and the tendon is brought down through this tunnel to the dorsal incision. With the foot in full dorsiflexion an estimate of the amount of tendon to be drawn down through the drill hole is made, and this section is then denuded of epi- and peritendon. Using No. 12 cotton, through-and-through suture is started at the end of the tendon. The ends of this suture are carried through a long Keith needle, guided through the drill hole by means of a grooved director, and brought out through the skin at the medial aspect of the foot" (fig. 11). "Grasping the two ends of the thread, the tendon is pulled well down into the drill hole with the estimated degree of tension on the muscle belly. A rolled sponge is placed between the two ends of the suture, which are then tied over it, thus anchoring the tendon in proper position. (A modification is to bring the needle out through incision number 2 and suture the thread ends through the fascia over the first cuneiform.) Two small stay sutures of No. 80 cotton are placed through the tendon and periosteum at the entrance to the tunnel, and for further security a slip of the tibialis anticus tendon is split off and sutured into a small slit in the transplanted tibialis posticus" (fig. 12). "The incisions are closed and a plaster boot applied, with the foot at a right angle in slight valgus. The plaster is bivalved at the end of four weeks. The suture in the tendon is removed by cutting the thread on one side and pulling on the other end. A toe-drop brace is applied and physiotherapy begun. A split plaster is worn at night for four to six weeks, at which time the brace may also be discarded."

Fig. 11.—Transplantation of the Tibialis Posticus to the Dorsum of the Foot for Equinovarus Deformity. A strong suture is carefully inserted into the end of the transplanted tendon and with it the tendon is drawn firmly down into a hole drilled through the second cuneiform bone. Fig. 12.—Transplantation of the Tibialis Posticus to the Dorsum of the Foot for Equinovarus Deformity. With the foot held in valgus and dorsiflexion, the ends of the suture are tied over a small roll of gauze. The action of this tendon in its transplanted position largely restores muscle balance in the foot and prevents recurrence of the deformity.

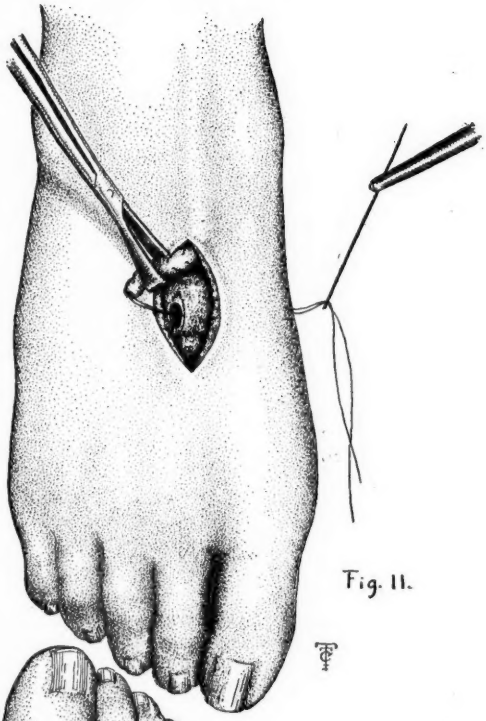

Fig. 11.

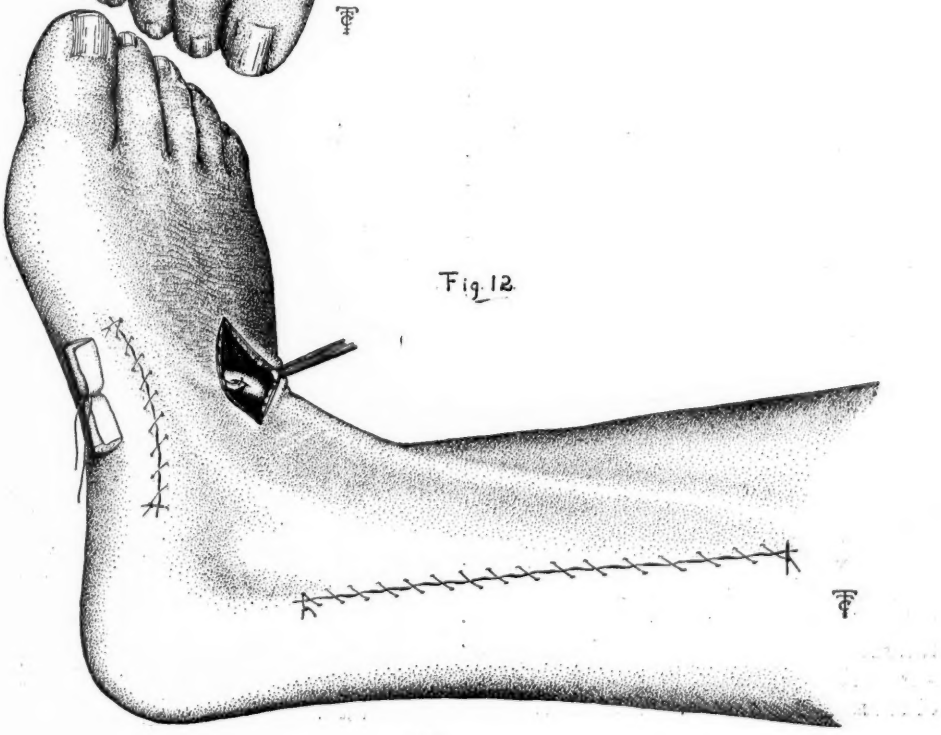

Fig. 12

For a more extensive discussion of the problems involved in irreparable nerve damage and a more detailed description of operative procedures the reader is referred to the many excellent treatises on this subject. Outstanding among these are the two volumes edited by Sir Robert Jones after the last war and entitled "Orthopaedic Surgery of Injuries," the "Lectures on Peace and War Orthopedic Surgery" and the "Lectures on Reconstruction Surgery of the Extremities" presented at the American Academy of Orthopedic Surgeons in 1943 and 1944, also Dr. Sterling Bunnell's comprehensive volume entitled "Surgery of the Hand."

RESUMÉ

Les lésions irréparable des nerfs sont ordinairement associées à des lésions d'autres tissues et entraínent une perte de sensation et de mouvements. Avant de décrire ses différentes opérations personnelles, l'auteur nous donne un résumé de la nature et de l'éntendue des lésions qui peuvent confronter l'opérateur. Il nous donne en détail les opérations qui permettent le transfert de differents groupes de muscles à d'autres insertions et ainsi restitue en partie, le pouvoir du malade de mouvoir et d'user la main ou le pied paralysés.

RESUMEN

Las lesiones irreparables de los nervios, generalmente acompañadas de extensas lesiones de otros tejidos, dan como resultado la pérdida de la sensación y del movimiento. Los que intenten reparar las mencionadas lesiones, deben colocarse en una posición absolutamente realista. Antes de describir sus varias operaciones, el autor analiza el caracter y la extensión de las lesiones que con mayor probabilidad se encuentran, después de lo cual entra a detallar los métodos operatorios en virtud de los cuales transplanta varios grupos de músculos a nuevas inserciones, restaurando así, por lo menos parcialmente, la habilidad del paciente para ejecutar movimientos y poder usar la mano o el pie paralizados.

Свод

Непоправимое повреждение нерва, обыкновенно, сопровождается широким повреждением других тканей и потерей чувствительности и движения. Тот, кто хочет поправить такое повреждение должен быть вполне реалистичным. Автор сначала дает обзор типов и степени найболее вероятных повреждений. Затем он подробно описывает разные операции, в которых он трансплантирует группы мышц к новым прикреплениям, восстановляя таким образом, по крайней мере частично, способность больного двигать и употреблять парализованную руку или ногу.

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(Continued from page 115)

SUMMARY

One case of osteoid-osteoma of a cervical spinous process is presented. Its clinical features, roentgenographic aspects and microscopic characteristics are discussed. Treatment, consisting of surgical excision of the involved process, with complete relief of all symptoms, is described.

RÉSUMÉ

L'auteur présente un cas d'ostéome-ostéoide de l'apophyse epineuse cervicale. Il discuté les signes cliniques, les aspects roentgenographiques et les caractéristiques microscopiques de cette lésion. Traitement: l'ablation de l'apophyse est suivie du soluagement de tous les symptômes.

RESUMEN

Se presenta en éste artículo un caso de osteoma-osteoide de las apófisis espinosas de la región cervical, y el autor discute sus características clínicas, el aspecto roentgenográfico y las peculiaridades microscópicas. Asimismo se describe el tratamiento que consiste en la extirpación quirúrgica de las apófisis afectadas, lo cual va seguido del alivio completo de los síntomas.

Свод

Описан случай остеоидной остеомы шейного позвоночного отростка. Даны его клинические, рентгенографические и микроскопические характерные черты. Описано лечение, состоящее в хирургической резекции вовлеченного отростка.

Pseudoarthrosis of the Neck of the Femur

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ACTIVE and frequent surgical intervention in the treatment of fractures of the neck of the femur in cases of traumatic epiphyseal dislocation, as also in certain conditions of juvenile epiphyseolysis, tend to lessen considerably the percentage of defective union and pseudoarthrosis of the neck of the femur, which, until a few years ago, was large, according to all available statistics.

The treatment of these fractures was far from attaining a desirable assurance of success, hence Kellog Speed was led to classify fracture of the neck of the femur as "the unsolved fracture." In point of fact, however, we are far removed from the time when, for the treatment of this fracture and its consequences, there were available only means which afforded no assurance of success except in a limited number of cases.

According to the study of the subject carried out by Osgood, Campbell and Orr in 1930, the proportion of satisfactory results in cases where the patients were over 60 years of age was only 30 per cent, or 52 per cent where they were under this age.

Exceptionally, statistics furnished by Leadbetter in 1938 relative to his own practice indicate a high percentage of cures effected by means of the old-established method of treatment. From a total of 81 cases treated, he states only 22 per cent were unsuccessful, while 71 per cent had good results. This surgeon, a great advocate of the old established method of treating this type of fracture, attributes his success to the technic employed in the exact reduction of the fracture and immobilization secured by means of a plaster cast. His technic for the reduction is in all points similar to that already employed by Dupuytren, and which some operators are still employing today.

Notwithstanding all improvements in technic, there is still the risk of certain serious consequences when fractures of the neck of the femur are treated, especially when they are sub-capital and transcervical, or, in Astley Cooper's onetime classification, intra-capsular fractures. Defective union, and in particular pseudoarthrosis, are incidents much to be be feared, which lead the surgeon to follow in therapeutics a line which modern experience in metallic fixation has indicated as that which will ensure perfect union in about 90 per cent of cases, according to the most reliable statistics.

In spite of these results, the Barcelona surgeon, Soler-Roig, in a work published late in 1943, states that, in his opinion, all methods hitherto employed, "may yield good results, but none of them guarantee a really solid union," and he affirms that even yet full agreement has not been reached with regard to the treatment of fractures of the neck of the femur of the various intracapsular types. In the treatise in question the author also states the following: "I practice systematically the same osteotomy for all sub-capital and transcervical fractures, both in my surgical ward and in my private practice. Whether on the day of the accident or some days later, I operate in the majority of cases after continuous ex-

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tension with Klapp's wires. I am convinced that osteotomy is the operation indicated for all true fractures of the neck of the femur, which, without such intervention, develop pseudoarthrosis in most cases." With these words Soler-Roig ends his treatise, and they represent the conclusion he has reached as the result of his giving thought to a problem which, in his experience, has no definite solution.

Without adopting any such pessimistic view, I do not doubt that even nowadays, a great number of cases of pseudoarthrosis of the neck of the femur still occur; but I am convinced that technical improvement of the methods of fixation, and their employment becoming more general, the number of such cases will be more and more reduced, giving place to notable progress in this difficult field of traumatology.

Careful selection of each case and the employment of technics which have now been simplified, have been productive of a large number of good results, as has already been demonstrated. The most reliable statistics published relative to the treatment of recent fractures of the neck of the femur indicate only 10 per cent of failures.

If even yet there are many cases of pseudoarthrosis, I am convinced that this is largely due to lack of care in the choice of the method to be followed, and of lack of adequate provision for the treatment of fractures in many centers where the problem has not yet been dealt with on up-to-date and definite lines such as have been laid down almost throughout the world.

As used to be said by our Professor Putti, the problem of how to treat fractures is one of organization. In point of fact, the better organized the centers destined to deal with them, the better the results achieved. This is definite, and I feel that nothing more need be said about it.

When pseudoarthrosis sets in, it raises a problem which, until recently, was of very uncertain solution. Progress in surgery contributes greatly to the solution of this problem, now offering in this field possibilities which were for long unknown. When pseudoarthrosis made its appearance, the patient was doomed to be a lifelong invalid. Surgical intervention has favorably affected the scale of results, which were so uncertain under methods which were conservative and of nonintervention.

Surgical intervention, as now practised, can be applied without great risk, even in cases where the patient is elderly. I recall that even in 1933, Masmonteil, among other writers, in a treatise on osteoarticular surgery, advised abstention in cases where elderly patients were concerned, maintaining that such intervention should be restricted to the relatively young. For these he prescribed open reduction combined with osteosynthesis and bone grafting.

In the 1924 French Congress of Surgery, Dujarier spoke in favor of surgical treatment for pseudoarthrosis of the neck of the femur by means of autografting with a bone fragment from the fibula. Similarly, Henderson in America and Lecéne in France declared this method to be the best, making reference to the 91 per cent of good results obtained.

In 1940 Henderson, when publishing the results of the 67 cases on whom he had operated between 1913 and 1939, revealed the excellent results obtained in his experience, 69 per cent of satisfactory union and 28 per cent of failures, not including two cases of death through embolism.

In his treatise, he does not compare

the method with others, but stresses careful selection of cases in which the treatment is indicated and makes reference to how improved technic warrants its more general application and a better employment of bone grafting, utilizing the extra-articular route, as he has been doing of late. Peroneal grafting was the method already employed by Noordenbos in 1914 for recent fractures of the neck of the femur. Later he employed it also when treating pseudo-arthrosis of the same bony segment.

Said Lecéne, "as what is in view is to obtain the formation of a perfectly solid bony callous, rather than to ensure correct shortening of the limb, the peroneal graft yielded satisfactory results when employed in the extra-articular position by the experienced surgeon." However, this technic has not become so generally adopted as was to be expected.

Although obtaining the bone for grafting was not difficult, and the technic of its extra-articular application presented no serious hindrances, it is the case that its employment was not widely adopted, giving place to a preference by some surgeons for tibial grafting, on the ground that it offers more bone-producing capacity for the union. In his statistics, Henderson mentions having employed tibial grafting in 32 cases and peroneal grafting in 55 cases, which shows him to be in disagreement with the other opinions. With a view to solving the problem, many and various technics have been employed, all of them with intent to ensure stability of the hip. Others go beyond this and seek to secure the most perfect anatomical reconstruction obtainable, in order to provide satisfactory functional recovery.

All sorts of methods have been put forward by those advocating them, and they have been tried, modified and discarded; to begin with, arthrodesis, practised by Gill and others as a last resort in certain cases, leading up to resections and reconstructive intervention.

The most widely known technic is that of Royal Whitman, as modified by Albee and Campbell. Others are those of Colonna, Luck, Brackett, Anschutz and others.

These consist fundamentally of resection of the head of the femur, transplanting of the great trochanter and implantation of the cervical part of the femur into the acetabulum. They differ from each other in technical details. In the main they are reconstructive operations to be employed as a last resort, requiring delicate technic and liable to eventual complications, local or general. They are interventions which do not always afford assurance of absolute success, and which at times involve risk to the life of the patient, though in some cases they do produce good results.

L. Zeno concedes to such methods a merely historical value, while he gives preference to the up-to-date methods, basing his conclusions on his wide experience. He is an authority to whom it is well to give heed.

Observation of facts and a tendency to seek to simplify the operation and obtain more success, impelled Albee, Campbell and Henderson, as well as Ellis Jones, Dickson and Compére to have recourse to technics other than those previously in vogue. Hence they availed themselves of mixed technics of plastic surgery, bone grafting and fixation by bony plates or pins, as described by them in various treatises. These have been practiced by other surgeons with more or less success.

However, the more frequent adoption of the method of metallic fixation, as instituted by Smith Peterson and modified by Sven Johanssen, for the treat-

ment of recent fractures of the neck of the femur, led to its being applied also to the treatment of fractures not of recent occurrence, and to pseudoarthrosis. It has been so applied in many instances, both in its original form or in one or other of the many modifications it has undergone.

Up to a point, it may now be considered a routine method, so much so that Böhler, Zeno, Marottoli and other writers on the subject affirm they employ no other process in the treatment of pseudoarthrosis of the neck of the femur.

The measure of success obtained justifies its employment in lieu of many of the methods of intervention suggested for the solving of this so difficult problem, now within sight of a more definite and favorable solution than appeared possible a few years ago.

Nevertheless, in my opinion, though its technic has been simplified, this method should not be indiscriminately employed in all cases.

In his book, "Fractures and Joint Injuries," Watson Jones sets forth with perfection of synthesis, the indications and contraindications, and lays down the lines to be followed. Thus this author states that choice of the process to be adopted should depend on the avascular necrosis of the head and the reabsorption of the neck of the femur. Both for fixation by pin and for other forms of intervention, guidance is afforded by the biological condition of the upper extremity of the femur. Thus Watson Jones deems obsolete certain methods of intervention, and recommends reconstructive operations on the lines advocated by Whitman, Colonna or Brackett, only in cases of great absorption of the neck or necrosis of the head. Fixation by nail or graft is contraindicated, as not giving promise of success in such cases. The same author recommends abductive osteotomy as the preferable form of intervention in cases of slight absorption of the neck and good vitality of the head, and bifurcation osteotomy, as by Lorenz, for cases of great reabsorption of the femoral neck.

In practice, only roentgenographic examination can afford the necessary guidance in the choice of the method to be employed. The roentgenogram furnishes the required knowledge of the condition of vitality of the bone fragments. Especially when examining the head, it is most important to observe the phenomena of avascularization.

These phenomena are observable roentgenographically as an increased density, indicative of necrosis, and thus of lack of biological means to ensure union. Due appreciation of this phenomenon is sufficient to set aside certain means of intervention, such as metallic or even bony fixation, seeing that the biological conditions will not promise success as the result of such intervention. None the less, according to what is set forth by Logroscino, it is a fact that the fractured femoral epiphysis is capable of maintaining a certain vitality derived from the synovial membrane, which would seem to afford the possibility of union. In one of his treatises the same author indicates that the biological basis of the prognosis of fractures of the neck of the femur is mainly as follows: "type and situation of fracture, type and extent of the vascular lesions peculiar to each variety of fracture, aspect and evolution of radiographic appearance of the proximal bony fragment."

As the epiphysis may be in such a condition of biological activity as to permit of securing an anatomical reconstruction of the neck of the femur, it

would seem permissible to seek to obtain this by employing the surgical means at our disposal, either by mechanical fixation or by osteotomy.

However, experience has demonstrated that the latter method offers assurance that satisfactory results will be achieved whenever mechanical fixation is not indicated. I agree with Böhler, Zeno, Marottoli and other authorities that whenever it is possible to secure perfect reduction of the fragments, the application of a triangular metal nail, in accordance with Sven Johanssen's method, is, in many instances, the means to be adopted in cases of pseudoarthrosis, as also in recent fractures of the intracapsular variety. But undoubtedly osteotomy can, in certain cases, solve a problem which often cannot be solved by mechanical fixation, since anatomical and biological conditions may render it inadvisable to practice such intervention, lest it should compromise the outcome.

Not so much are the age of the patient and his general condition factors to be taken into consideration, but rather, and most decisively, those factors already instanced as the most important for affording indication of what treatment is to be preferred, and which are fundamentally due to the biological condition of the neck and the head of the femur.

It is known that osteotomy is not free from risk and that it presents no fewer technical difficulties, while too it is not less dangerous than metallic fixation. Both require to be under roentgenologic control while the operation is being performed. They also demand adequate experience and equipment. These interventions cannot be substituted the one for the other, since their respective objectives are not the same.

If mechanical fixation, as applied in the treatment of pseudoarthrosis, is the method to be preferred in many cases susceptible to functional and anatomical repair such as will ensure satisfactory results, none the less are there cases where definitely it is not indicated and even is technically impossible to effect. What then are such cases? All those in which decalcification and progressive reabsorption of the cervical portion give rise to conditions whereby there is a space between the head and the trochanteric mass, which space is filled by fibrous tissue, usually found in long-standing fractures.

Nowadays we know that, notwithstanding this, there are cases of metallic fixation in which ossification can be obtained at this point, but it is not to be expected that the reabsorbed cervical portion will be reconstructed.

Such condition may be changed for the better by osteotomy, which in about 50 per cent of cases, will promote perfect consolidation.

Simple abduction osteotomy acts on the site of fracture by indirect pressure and permits of a cure in fractures showing delayed union; but it is not indicated in true pseudoarthrosis or in cases of great cervical reabsorption.

The postulates put forward by Putti present indications which are useful guides:

(1) "Providing the upper extremity of the femur with new and more favorable architecture, it is possible by means of a direct and prolonged force to stimulate the process of consolidation.

(2) "Reestablishing more direct and firm contact between the fragments and preventing eventual change of position by means of exact adjustment of the axis of the force between the fractured surfaces, the process of revascularization is assisted, thus being developed through the newly formed vessels con-

necting the segment having the greater blood supply with that which has the lesser."

This result can be attained by the employment of osteotomy with a precise technic. Osteotomy was practiced in the treatment of pseudoarthrosis by Pauwels, Camitz, Hass, Etorre, Putti, McMurray and others, with various modifications.

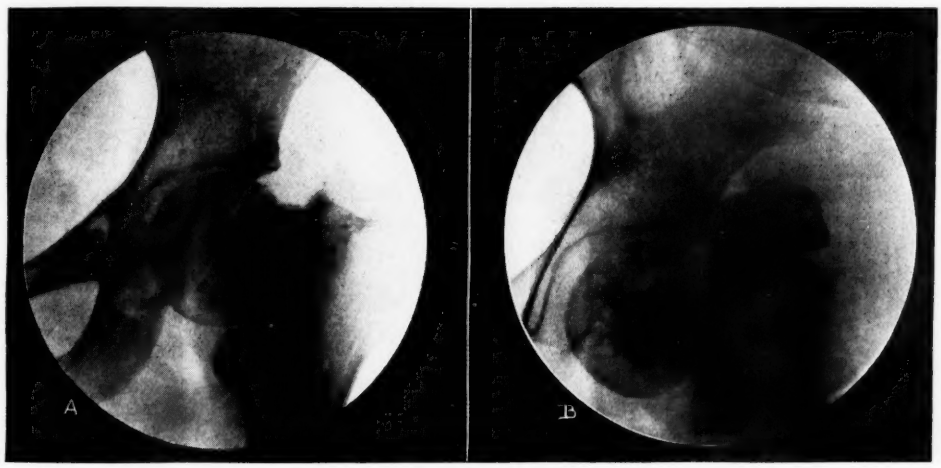

Fig. 1.

With other objectives, it had already been utilized in 1894 by Kirmisson, and later by Hoffa, Ludloff, Schanz and, with further modification by Lorenz.

Putti's intertrochanteric osteotomy had two objectives in view, as it sought not only to secure static and mechanical equilibrium, but also to promote a change consisting of consolidation of the pseudoarthrosis, which he reckoned would take place in 50 per cent of the cases in his statistics. Experience has proved it possible to promote by this means a functional recuperation not obtainable by the old established treatment.

Subtrochanteric osteotomy, as practiced and advocated by Etorre since 1931 for the treatment of pseudoarthrosis of the neck of the femur, and even for recent fractures in such cases as he deemed could not be otherwise treated, whether by old established methods or surgically, induced this surgeon to propose that it should be widely employed. This opinion may possibly be modified in the present day, as the result of progress and of experience gained in the technic of metallic fixation. For cases where pinning cannot be effected, the various types of intertrochanteric osteotomy offer advantages as compared with subtrochanteric. One of the main advantages is the possibility of securing more perfect reconstruction of the supporting axis of the limb, as also firmer consolidation at the level of the pseudoarthrosis itself. Hence, consolidation and supporting axis are the objectives to be secured, which are fundamentally calculated to bring about functional recuperation as nearly normal as possible.

Intertrochanteric osteotomy affords the possibility of placing the divided segment of the diaphysis under the two

fragments—the fractured epiphysis and the divided trochanter—thus doing away with the cervicodiaphyseal angle, as is shown in fig. 1.

This method is absolutely different from that put forward by Pauwels, who sought to solve the problem on a mechanical basis. To this end he proposed cuneiform osteotomy, as indicated by fig. 2. The main objection to this method, over and above the fact that it presents greater technical difficulties, is that the rise of the great trochanter in cases of pseudoarthrosis, will not easily permit of internal rotation and the alteration of the line of fracture to the horizontal plane, as indicated by Pauwels for a phase of his method.

Putti, with his great experience and his practical skill, advocated as preferable, transtrochanteric rather than subtrochanteric osteotomy, repudiating Pauwels' cuneiform osteotomy, as he attributed to it a merely theoretic value.

Basing his opinion on his experience of cuneiform osteotomy in general, he counselled linear osteotomy in preference. In the case I describe, the same principles were followed, though I introduced such modification as was required in order to achieve reconstruction of the neck of the femur, while taking advantage of the special conditions for effecting this, presented by my case.

From this point of view, my technic differs from those described by their respective advocates already named.

Instead of producing a consolidated block which, subsequent to linear osteotomy, should place the small trochanter in a position below the head of the femur, as indicated in fig. 1, I sought to obtain a partial reconstruction of the neck of the femur, though it meant a metaphyseal bony spur, as indicated by figs. 1*B* and 3.

To bring this about, I had to avail myself of a new method of intervention. Similarly, I effected a linear osteotomy, reaching to the cephalic portion. Osteotomy was effected in the trochanteric mass a few centimeters below the greater trochanter instead of a few centimeters above the lesser trochanter, as is the rule in Putti's technic. By this means, the formation of a spur was

Fig. 2.

obtained, which, when abduction through 50 degrees with the diaphysis was effected, penetrated the head without producing noticeable deformity, as is shown by the roentgenogram.

Thus, in lieu of a block formed by the three bony segments, a femoral neck was produced, disappearance of pseudoarthrosis having been rendered possible by the consolidation obtained, this having been periodically controlled.

It proved possible also to obtain by this means a solution of the mechanicostatic and functional problem, since the axis of load and support was brought into harmony with the diaphyseal axis, external rotation of the limb having been overcome.

A year after the operation, I was able to verify that the functional, esthetic and clinical results were satisfactory, as the patient did not complain of pain and the difference in the length of her limbs was very slight.

She was a young woman, 25 years of age, who had been unable to move for a long while, subsequent to a fracture of the neck of the femur which had been treated away from a surgical center. The fracture had been followed by pseudoarthrosis, which had been without treatment for many months (fig. 1*A*). She was operated by us in 1944, in the service of our Professor Francisco Gentil, according to the technic above mentioned.

True, to employ this technic will not always be possible; but, as in the case of other technics, the choice must wholly depend on roentgenographic observation rather than on any other factor. The position of the head in relation to the diaphysis, its position in the acetabulum and above all its roentgenographic appearance, demonstrating its condition, are the factors to be taken into account for selecting the process of intervention. The various appearances which the femoral head may display, from increase of opacity, revealing a necrotic condition, to total decalcification of the area, are indications according to which the mode of intervention for the solution of the problem should be chosen.

An appearance but little removed from the normal offers conditions for success in the recovery it is sought to effect. In this case, it will be well to seek an anatomical reconstruction approaching normal anatomical morphology.

As may be noted, by means of this technic I have succeeded in obtaining morphological reconstruction of the hip, reestablishing the axis of gravity in the line of the femoral axis; an objective to be desired whenever it is sought to secure a satisfactory functional result.

The principle inspiring Putti when he idealized his low intertrochanteric osteotomy, was that there should be built up

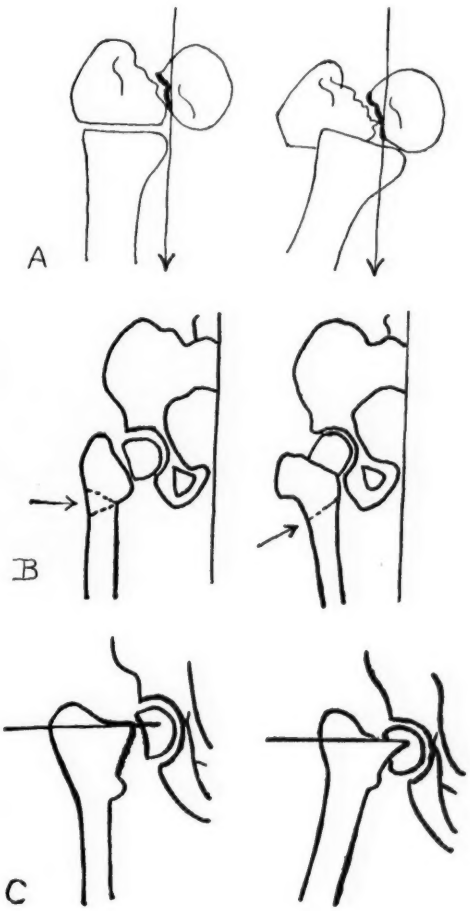

Fig. 3.

a structure affording solid support, even should this entail much morphological alteration. If it should prove possible to secure similar functional results along with anatomical reconstruction approaching the normal, the

more advisable will be the intervention I am wont to practice. As indicated by Albee in a treatise published in 1940, one of the main objectives is to ensure removal of functional muscular equilibrium, in order that the hip joint may work satisfactorily.

The method of intervention I have adopted provides for this, as is demonstrated by the results obtained (Fig. 3).

The more external position in which the greater trochanter with its muscular insertions has been left, has produced an elongation and an increase in muscular tension in the pelvitrochanteric muscles, from which has resulted physiological equilibrium, the basis of all normal functioning. Along with this, it was possible to secure elimination of excessive external rotation of the femur, and from this combination there was secured a stability and a functional mechanism which rendered feasible operational results justifying the use of the intervention.

I am thus of the opinion that the resources now available by means of metallic fixation and intertrochanteric osteotomy, with the precise indication they afford, make it possible in almost all cases to solve a problem which for long was deemed insoluble, or which was sometimes solved by means of painful interventions lacking the certainty of success.

Recalling Putti's assertion that no monopoly of osteotomy to the exclusion of osteosynthesis can be maintained, I am also of the opinion that neither can a monopoly of osteosynthesis to the systematic exclusion of osteotomy be maintained for all cases.

Though it is not an intervention which can be effected without difficulties, the results obtained lead me to judge that the publication of this treatise may prove of interest, and I would dedicate it to the memory of Albee, who is now being remembered with veneration.

SUMMARY

After outlining and discussing at some length, most of the modern methods of dealing with pseudoarthrosis of the neck of the femur—with due credit to the technicians who introduced them—the author describes his own modification of these methods. He offers, in illustration, the case of a woman, aged 25, who had been unable to move for many months prior to his operation, upon whom, apparently, he was able to obtain good results, as demonstrated by his illustrations.

RESUMEN

Después de detallar y estudiar con cierta extensión la mayoría de los métodos modernos de tratamiento de la pseudoartrosis del cuello femoral—con el debido reconocimiento de los técnicos que introdujeron aquellos métodos—el autor describe sus propias modificaciones a estos procedimientos. Como ilustración expone el caso de una mujer de 25 años que se hallaba incapacitada de moverse por un período de varios meses antes de la operación. En éste caso el autor consiguió con la intervención quirúrgica muy buenos resultados como demuestra en el artículo.

RÉSUMÉ

Après avoir décrit et discute la plupart des méthodes modernes employées dans le traitement des pseudarthroses du col du fémur—tout en reconnaissant les mérites des techniciens qui les ont introduites—l'auteur décrit sa modification personnelle de ces méthodes. Il présente le cas d'une patiente agée de 25 ans. Pour plusieurs mois avant l'opération, cette malade avait perdu

l'usage du membre lése. Il montre des illustrations qui démontreut l'excellence des résultats obtenus par sa méthode.

Свод

После краткого обзора и более подробного обсуждения почти всех новых способов лечения псевдоартроза шейки бедра, а также отдавши должную честь тем, кто их ввел в употребление, автор описывает свою собственную модификацию этих метод. Как иллюстрацию, он приводит случай 25-летней женщины, которая не могла двигаться в течении нескольких месяцев до его операции и в которой он сумел получить хорошие результаты, как его иллюстрации демонстрируют.

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Examination of the Spine

"If a deepened midline spinal sulcus is seen about the tenth dorsal vertebra you have noticed the first sign of Pott's disease in its earliest stages at the most frequent site. This deepened sulcus is due to increased muscular tonicity of the erector spinae muscles; it is nature's plaster cast (Jardine, Francis E., *Contemporary Surgeon, Edinburgh Royal Infirmary).*

"Ask the patient to bend down and touch his toes. The mobility of the spine is tested by this means. Usually if the patient is a small child, this information can be obtained without tears, by dropping a coin upon the floor and watching the child pick it up. A normal child will pick it up by flexing the spine, or, at least the spine will be flexed to a considerable degree. On the other hand, if the child picks up the coin very cautiously by bending the knees, it is obvious that spinal rigidity is present. The mobility of the spine can also be tested in young children by laying them on the face and lifting up the feet. Rigidity is an early and constant feature of Pott's disease."

(From "Physical Signs in Clinical Surgery" by Hamilton Bailey, F.R.C.S., F.I.C.S.; Bristol, England, John Wright & Sons, Ltd., 1944.)

The Fifth International Assembly of the International College of Surgeons

AS President of the International College of Surgeons, it is my privilege and great honor to address words of welcome and greeting to the delegates, visiting surgeons, scientists and medical men from all parts of the world who are attending the Assembly.

These are days of international interest throughout the world, as never before in history. This interest, primarily born in national aspirations and for self existence, is urged and propounded by the force of modern progress and evolution with compelling evidence which makes science the common property of mankind.

We are living today in a spirit of internationalism as a goal and product of our civilization. One world, one common effort under international desires for the perfection of knowledge and for the peace and amity of humanity. The International College of Surgeons has undisputed existence as the vehicle by which national aspirations are united under one banner of international brotherhood and co-operation and it can and will exert its influence to attain the sacred purposes of an international brotherhood in science as well as in political, economic and other energies in which mankind is primarily interested.

The International College was conceived and founded with purposes and objectives transcending any scope heretofore projected in the art and science of surgery, bringing into close collaboration the foremost exponents of proficiency and ethics in surgery and surgical specialties.

The College and its Chapters in all parts of the world constitute the integral organization which, by democratic channels, seek to make available to aspiring young surgeons the best of the world's facilities and opportunities for training and experience to insure learned and skilled practice of surgery in general and in its correlated specialties.

The Fifth International Assembly of the International College of Surgeons, to be held in Lima, Peru, March 24 to 27 inc., at the invitation of the Government of Peru and jointly with the national medical organizations, universities and hospitals in that great historic capital, is destined to record its achievements as epoch-making in the annals of modern progress.

DÉSIDERIO ROMÁN,
M.D., F.A.C.S., F.I.C.S

Enabling Useless Thigh-Stumps to Move a Prothesis

J. F. S. ESSER, M.D., F.I.C.S. (Hon.)

OPERATIONS to lengthen useless thigh-stumps are very difficult, in regard to skin covering and their being combined with muscle tissue. Many years ago I had already introduced and practiced a method which gives good results; the technique, however, demands great precision. The result, though, is surprising, as the lengthening of useless thigh-stumps by many inches gives the patient power to move and use a prothesis. Because the axis of rotation (fig. 1-A, *a–x*) runs through the collum, only a small part of the femur can move the prothesis. After my operation, this part is lengthened by the part proximal to the axis, and the lengthened part, distal to the axis, is much more than doubled (fig. 1-B, *a–x*).

If the femur is four inches long when measured from the top of the trochanter major, half its length is above and half below the turning axis. The latter half only can be taken into consideration in respect to moving the prothesis. With my method, the length of the femur is doubled, so that the original four inches are lengthened to eight. The working part which moves the prothesis is increased by four inches so that it becomes six, instead of two. (See figs. 1-A and 1-B.) Also, the end of the femur is no longer buried in fat and muscles. The stump becomes conical, and its end, consisting only of bone with unscarred skin and subdermis, can consequently enter a prothesis.

In fig. 1-A, *a–x* is the turning axis and *b–y* the length of the thigh-stump; only the lower portion of the latter can attempt to move the prothesis.

My operation consists of separating the outer part of the thigh-bone from the inner part and turning it downward, so that the ends of the two parts are placed one against the other. The former top of the outer part becomes the end of the stump *d* (fig. 1-B).

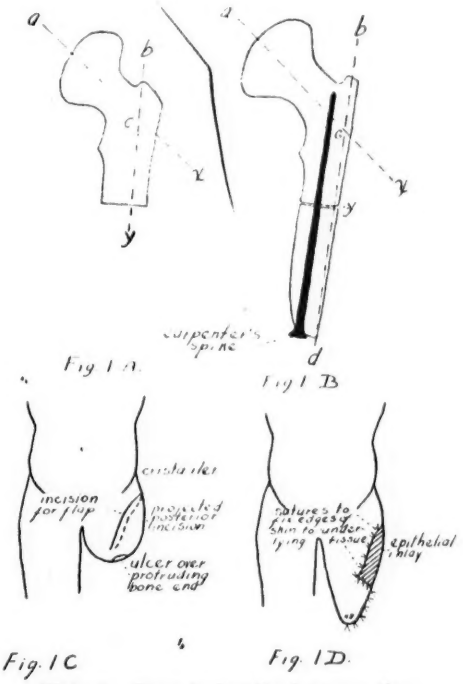

Plate 1.—Steps in lengthening operation.

In this way, the part which moves the prothesis has become the length *c–d* instead of *c–y*. The descending piece of bone is fixed in its position by a very long, strong carpenter's spike, which passes through the axes of both portions (fig. 1-B).

Fig. 3 shows a portion of the body before the operation. The incision made for the proposed flap, which has to contain the descending bony part and the

surrounding muscles and skin, is indicated on the sketch. Fig. 4 shows the result of the lengthening.

The secondary defect at the place from which the pedicled flap of skin, muscle, and bone is taken is first considerably reduced, either by stitches fixing the skin of the edge to the underlying tissue, or by putting a long silk thread all around through the skin border of this defect; this thread must be knotted together with some tension, so that the area of the defect is decreased. The consequent rather small defect is covered in the same session by an Esser-inlay, i.e., a free and very thin skin graft, put over a negative mold (of the dental compound—Stent) of the wound. This mold is placed with the graft on the wound in just the way that the mold was taken. Pressure is put on it for a week by a thin rubber band bandage. This pressure must be about equal to blood pressure, so that no bleeding or secretion can occur between the graft and the wound. This pressure favors flowing of the blood away from the wound. This reflux of blood and lymph is of greater value than their influx into the wound.

Plate 2.—Patient before and after lengthening operation.

The spike is taken out as soon as the ends of the bone have grown together solidly.

Plate 2-A shows a patient before the lengthening.

Plate 2-B shows a patient after the first bandage was removed. The black spots are dried blood and secretion not yet removed.

My inlay method, used in general in plastic, or structive, surgery, has been published in this review (May, 1943) and, at its birth in 1916, in *Bruns Beitrage,* and in *Annals of Surgery* in 1917.

RÉSUMÉ

L'auteur décrit un procédé pour l'allongement d'un moignon de la cuisse trop court, par la separation longitudinale du fémur. Cela obtient une plus grande longueur en dessous de l'axe de rotation. L'auteur décrit le procédé qu'il préconise pour réparer les lésions secondaires des tissus mous.

RESUMEN

Se describe un procedimiento para alargar un muñón muy corto de muslo mediante la separación longitudinal de la diáfisis femoral. Este método proporciona un alargamiento adicional por debajo del eje de rotación que es, precisamente, donde más se necesita. También se describe aquí la reparación secundaria de los tejidos blandos.

Свод

Описан способ удлинения очень короткой бедренной культи при помощи разделения в длину бедренного диафиза. Этот способ дает длину, где она наиболее нужна, именно, ниже оси вращения. Также описана починка вторичных дефектов мягких тканей.

Screw Fixation of Fractures

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WASHINGTON, D. C.

THE object of this paper is to illustrate the methods of screw fixation in various parts of the body. (I do not intend to claim superiority. The results have been relatively good in a short and recent series.) Most of the cases presented have had a sufficient follow-up to indicate satisfactory results, but an end report will be given in a subsequent paper. If the reasons for the use of screws can be demonstrated, as well as the manner in which various joints are approached, the purpose of this paper will have been fulfilled.

The fixation of fractures by the use of screws has never enjoyed much popularity. Although there are accounts of their use in fixing fractures for over a century, they have never been considered routinely satisfactory until recent years. They have been employed frequently, however, in conjunction with metal plates. In the past decade more use of screws, either singly or in groups, has been made for the fixation of fractures than in all the other decades of this century. The use of inert substances, such as vitallium, has made screw fixation more satisfactory. Until the advent of inert metallic substances, the incidence of necrosis and poor results was too great to permit enthusiasm toward their use. The reaction of the neighboring tissues to foreign substances, not only caused local inflammatory changes, but resulted in a loosening of the screw in the fragment, thereby preventing immobilization. Persistent draining sinuses were so frequently encountered, that further such attempts were abandoned. However, any one who has had occasion to remove a vitallium screw realizes that no tissue reaction occurs, and, therefore, one of the greatest hazards in the fixation of fractures has been overcome.

Screw fixation has its chief advantage in regions about joints. This is of particular value because one of the chief complications of fractures is contractures about neighboring joints. In most instances, a single screw is sufficient to permit immediate motion. Whenever this is not possible, two screws can be inserted in a slightly non-parallel direction. No casts or splinting are necessary. The value of immediate mobilization cannot be emphasized too greatly, for it maintains the normal physiology of the part as well as preventing considerable loss of time from fibrous ankylosis. The use of screws in the region of a joint is not difficult, because muscular tissue is not present to interfere with dissection. Bone exposure is usually possible through a 1 to 2 inch (2.5 to 5 cm.) incision. The fragment can often be palpated, and, under direct vision, fixed in position. Although fluoroscopic guidance for the insertion of the screws can be used with relative ease and great satisfaction, since there are few soft tissues to obscure visibility, it is usually not necessary. Therefore, in view of the ease of approach, requiring a minimum of surgery, and the satisfaction because of direct visualization, screws in the region of joints are recommended. However, this adaptability is not present for fixation of fractures in the midportion of a shaft. Plate fixation, or reduction and fixation with various types of apparatus, are more suitable in shaft areas.

Certain mechanical principles are involved in screw fixation of fractures:

A. The screws should pass preferably from cortical bone on the one fragment to or through the cortical bone of the corresponding fragment. This is not always possible. Some of the photographs which accompany this article reveal examples of the screw passing into the medulla of the shaft of the involved bone. In most instances the screw, while passing into the medulla, hugs the inner wall of the cortex and obtains a fairly good purchase. Frequently the screw will be bent slightly to follow the inner cortical wall. This prevents the screw from becoming loose.

B. Double screw fixation is sometimes more advantageous than single. This can be understood when one realizes that there is a tendency for the fragment to rotate. If two screws are inserted in a slightly non-parallel direction, such a rotation cannot occur. Certainly where a long lever effect is present, as in the region of the femoral neck, a single screw would not be satisfactory. In the region of the internal or external condyle of the humerus a single screw usually suffices. In most instances a single screw in the malleolus of the ankle fulfills its purpose.

C. It is not wise to fix a fragment which has been dislodged unless that fragment is needed. It would be much better to remove it if such removal does not interfere with growth or function. Fragments broken from the condyles of the lower humerus in an adult are not as important as in a child. They are not responsible for continued growth of the extremity. In some fractures of the multiple, comminuted type, numerous small fragments can be removed without interfering with function. "Heaping up" of callous in maintaining these small fragments would interfere with future function and would require greater time and effort on the part of the surgeon.

D. Vertical fixation should be used wherever it can be applied. Mechanically, it is more satisfactory and more easily accomplished. There is less chance of endangering vital structures. On weight bearing extremities, it does not present the disadvantage in shearing force that is found in fractures that have screws in a transverse direction. When a long screw is used in a vertical direction, it is surprising to find that the loose fragment is pulled into fairly accurate position by the screw which threads itself into the medulla of the main fragment.

Certain surgical principles should be followed, and are as important as the mechanical principles mentioned above:

A. Incision should be made over areas where friction will not occur. On the elbow it is preferable to have the incision over the lateral side of the olecranon. In fractures involving the region of the inner side of the knee the incision should be antero- or posteromedial. In fractures of the acromioclavicular joint, incision slightly anterior to the clavicle is preferable to one directly over the joint.

B. The incision should be made in the direction of the ligaments and muscles, rather than in a direction in which they will be severed. In fractures of the malleoli of the ankle, vertical incisions are preferable. The principle of following lines of skin cleavage is not applicable if such an incision requires the division of important ligamentous structures. The importance of ligaments to their respective joints cannot be too greatly stressed. The disability which occurs when such ligaments are divided

is not always appreciated. When ligaments have been sutured their function has been greatly affected, and the discomfort from the scarring is ofttimes marked.

C. Fascia and aponeuroses should not be detached, unless this is absolutely essential to obtain exposure of the fractured segment. To denude a fragment almost entirely of its aponeurotic and fascial covering will frequently lead to non-viability. It is preferable to pass the screw through the aponeurotic area rather than denude a large area. In most instances, a small incision in the direction of the fibers will permit the screw to be started in the fragment. It is not uncommon to find drainage in the region of the elbow joint or of the tibial plateau following attempts at internal fixation of these structures. Suppuration does not occur frequently, but necrosis is present with a persistent draining sinus for many weeks. The removal of the non-viable denuded ligamentous structure usually causes the drainage to cease.

The illustrations which accompany this article are of various parts of the body. Legends describe the method in that particular area. It is not to be implied that screw fixation is the best method in each particular case, but rather to show that it can be utilized in the manner shown. Undoubtedly fixation with heavy suture material, small nails, or possibly even in some cases, no fixation at all, might have been a better procedure. One must utilize the method which he feels will be most satisfactory in his own individual hands. In the cases shown I aim to stress the use of the screw particularly in

1. fractures of the upper ulna with a fracture of the radial head

2. fractures about the internal and external malleoli of the ankles, and

3. fractures of the tibial plateau and condyles of the femur.

Description of cases: A fracture involving the radial head or neck (fig. 1) and the upper portion of the olecranon

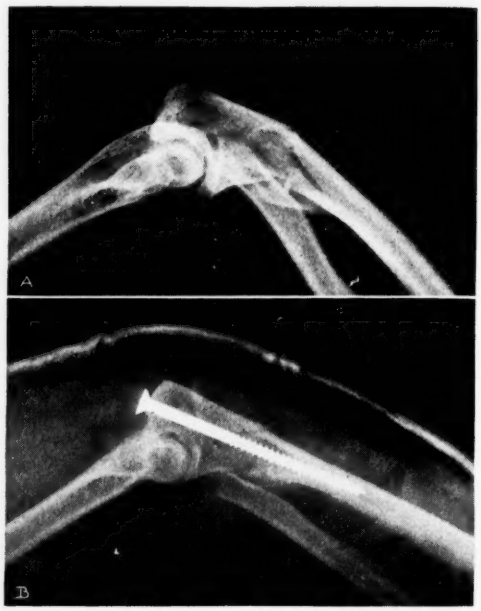

Fig. 1.—*A* Fracture of upper shaft of ulner and neck of radius. *B* Radial head removed; fixation of ulner.

(fig. 2) can be treated by a posterior approach just lateral to the olecranon with the incision extended along the upper shaft of the ulna. The radial head usually is easy to remove and the long screw is inserted into the shaft of the ulna. It is easily performed under direct vision and the fragments line up well, since the fragment is literally threaded over the screw. Motion can be started within a few days.

A 1 inch (2.5 cm.) incision often can be used for fractures of the humeral condyle (fig. 3). A screw of small diameter is preferable because of the narrowing of the supra-condylar region of the humerus. On the medial side,

the ulnar nerve, of course, must be avoided. The need for fixation to prevent growth disturbances in children must be recognized.

Treatment of fractures about the elbow has recently been described by Dr. Paul H. Harmon.[1] He uses a long stainless steel screw which is permitted to protrude through the skin and can be removed after union has taken place. MacAusland[2] uses a shorter screw buried beneath the skin at open operation. Rush and Rush[3] have described the use of longitudinal pins in extensively comminuted fractures of the upper half of the ulna.

In acromioclavicular separations, the insertion of a screw in the manner described by Bosworth has proved satisfactory (fig. 4). A large enough incision to permit palpation of the coracoid process is recommended. This method should not be used by one who is not trained in bone and joint surgery, since there is a danger to vital struc-

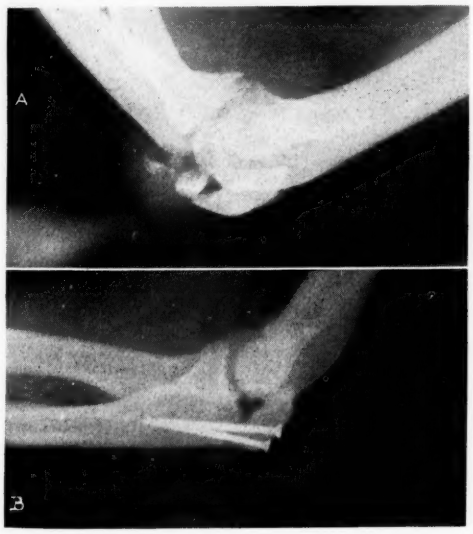

Fig. 2.—*A* Comminuted fracture of olecranon. *B* Nonessential fragments removed; double screw fixation.

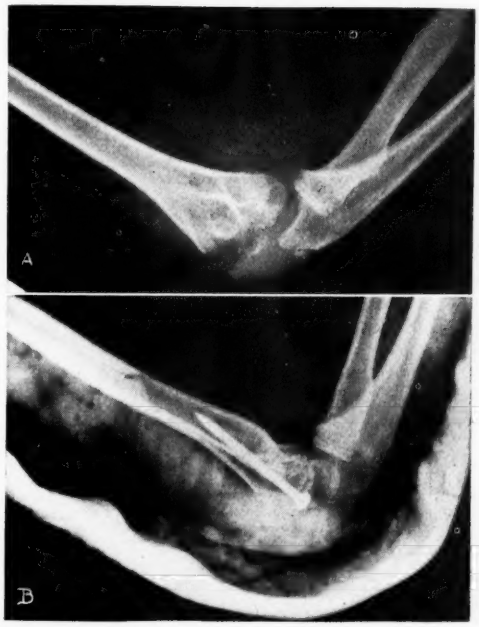

Fig. 3.—*A* Fracture of external humoral condyle with marked rotation. *B* Fixation by single vertical screw following reduction.

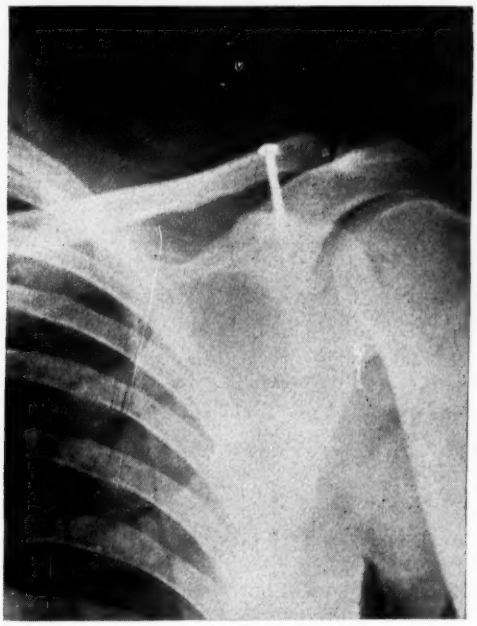

Fig. 4.—Method of maintaining reduction of acromioclavicular separation.

tures in this area if care be not used. Double screw insertion in a non-parallel direction has been found necessary and advantageous in one patient.

Fig. 5.—*A* Comminuted intercapsular fracture with dislodged fragment. *B* Maintenance of reduction with multiple screws.

An example of multiple screw fixation as described by Geckler in intracapsular fractures is shown (fig. 5). This method has been used in twenty

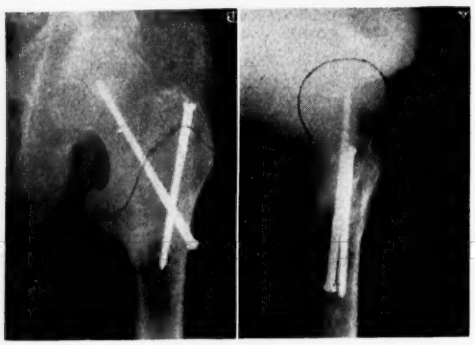

Fig. 6.—*A* Nondisplaced intertrochanteric fracture maintained by screws from opposite directions—front view. *B* Side view.

patients with fairly good results. Visualization with the fluoroscope during insertion is an aid. A more vertical fixation—that is, starting lower on the shaft than usually recommended—has given better results in some of our cases. The insertion of a screw with a Smith-Peterson nail has the advantage of preventing the loosening of the nail. Non-parallel fixation locks the fragments more satisfactorily, preventing rotation.

Simple intertrochanteric fractures can be treated by one screw inserted from the shaft into the femoral neck and a second screw from above downward from the greater trochanter into

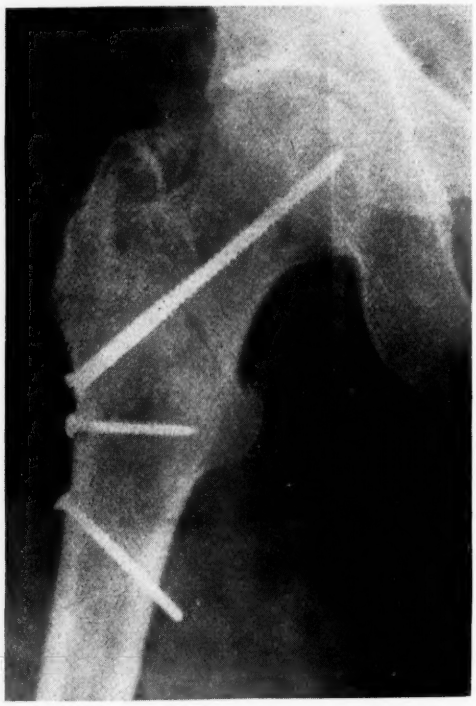

Fig. 7.—Comminuted, undisplaced intertrochanteric and upper femoral shaft fracture maintained by multiple, nonparallel screws.

the shaft. This locks the fragments by wide variation in direction. An example of this method is shown (fig. 6). There is also an example (fig. 7) of an intertrochanteric fracture which extends a distance of a few inches into the shaft. In this fracture, a screw was inserted in the direction of the neck, a second screw transversely through the linear fracture line and a third obliquely down-

wards through the lower portion of the linear fracture site. The intertrochanteric fractures described do not require incisions larger than one and one-half inch, and can be done with the aid of the fluoroscope. The latter procedures in intertrochanteric fractures are recommended, since a minimal amount of surgery is required. The Phillips type screw and screw driver is suggested, since it permits control of the screw at all times through the small incision. One of the chief values of screws in intertrochanteric fractures is that the soft tissues and skin can be sutured over the screw and therefore one does not have "seepage," such as frequently occurs when using an external fixation apparatus. Immediate motion of the part is possible. Local anesthesia can be used when required by the patient's condition.

In supracondylar oblique fractures of the knee joint, two long screws are usually inserted in a non-parallel direction (fig. 8) extending from one cortex through the bone and the opposite cortex. Immediate weight bearing is possible and the patient can move the knee joint through a normal range of motion. One can determine fairly accurately the diameter of the condylar area since there is very little soft tissue over this portion of the lower femur. The screws are placed in the loose fragment; the fragment is then manipulated into position under the fluoroscope and held there while the screw is driven through the bone into the opposite cortex.

In tibial plateau fractures, we have found that screws are as satisfactory as bolts and do not require a second incision on the opposite side of the knee. If a depressed fragment can be elevated without too much difficulty, this should be done. A detached meniscus should be removed. Where there is too great irregularity, because of multiple depressed fragments, it has been found valuable to remove the small fragments, providing the outer large fragments are elevated to their normal height. A single screw passing completely through the plateau area is necessary. A Kirschner wire or small Steinmann pin with a transfixing screw has frequently been used. One should be cautioned

Fig. 8.—*A* Comminuted intercondylar fracture of femur. *B* Double screw fixation after reduction.

against stripping too much fascia on the edges of the plateau in order to obtain good visualization. One of our patients had serous drainage for a period of six weeks from too much detachment of necessary blood supply resulting in necrosis. A depressed outer fragment usually can be elevated with a towel clip and held there as the screw is inserted into the main fragment. An osteotomy halfway through the upper tibia, approximately 1 inch (2.5 cm.) below the tibial plateau, in order to elevate a depressed fragment, is superior to stripping of the fragment, in order to obtain adequate exposure. When a partial osteotomy is performed the entire depressed area can be elevated and transfixed with the screw. The latter procedure may appear as radical as denuding the ligamentous tissues; however, it does not interfere

with the vascularity of the part to so great an extent, and from it we have had good results and no complications.

Unsatisfactory results (fig. 9) are often obtained in fractures of the internal and external malleoli. The residual disability in soldiers who have had fractures of the ankle has been frequently mentioned. A much better reduction can be obtained by an open approach, reëstablishing a more normal ankle mortise. These fractures are usually easy to approach. Immediate motion is obtained. Weight bearing can be started early. The posterior tibia at the ankle joint, however, requires more difficult surgery. Experience with it has not been as satisfactory. It can, however, be fixed with a screw. If the posterior loose fragment is not too large, it is sometimes preferable to remove it. When the screw is inserted into the internal or external malleolus, it should be done in the direction of the shaft, counter-sinking the screw.

Fig. 9.—*A* Bimalleolar fracture of ankle with displacement. *B* Single screw fixation of internal malleolus.

It is not recommended that tarsal fractures be routinely treated with screw fixation. These are individual problems. An example is shown (fig. 10) of a fractured tarsal scaphoid. The patient was able to bear weight on the foot immediately. Although this patient had an excellent result within a short period of time, an equally good result might have been obtained by removal of the fragment. Certainly screw fixation in most tarsal bones is unnecessary.

SUMMARY

A series of cases has been presented with photographs, showing screw fixation with a description of procedure and advantages. The ease of insertion is stressed. Certain mechanical and surgical principles should be followed.

Results in these cases have been uniformly good. Fractures about the elbow, knee and ankle joints lend themselves well to this method.

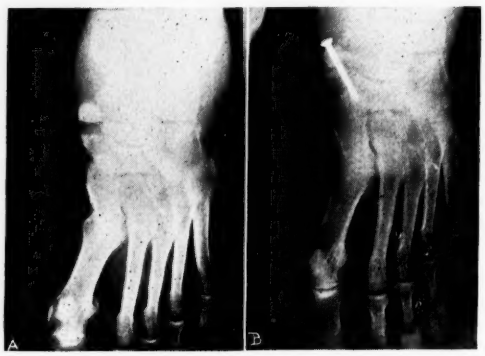

Fig. 10.—*A* Tarsal scaphoid fracture with displacement. *B* Maintenance with single screw.

CONCLUSION

Screw fixation can be accomplished about joints with relatively little surgery. It permits immediate mobilization. The end results are superior to plate fixation and are more positive than fixation by non-absorbable sutures. Fluoroscopy can be utilized satisfactorily because of the lack of soft tissue, making visualization easy and exact. When inert metallic screws, such as vitallium and stainless steel, are used, there is a lack of tissue reaction.

RÉSUMÉ

De cas sont presentés avec photographies de fixation à l'aide de vis. La méthode et ses avantages, sont décrits. Certains principes de mecanique et de chirurgie sont mentionnés. Les résultats sont excellents. Les fractures du coude, du genou et de la cheville se prêtent bien à ce procédé. La mobilité est immédiate et les résultats sont satisfaisants. Cette méthode est préférable à l'emploi de plaques ou des sutures non-absorbables. Vu le peu de tissu mou dans ces régions, la fluoroscopie peut être employée avec satisfaction, la visualisation est facile et exacte. L'emploi de vis de métal inerte assure le manque de reaction tissulaire.

RESUMEN

El autor presenta una serie de casos con ilustraciones fotográficas que muestran la fijación de las fracturas por medio de tornillos, describiendo la técnica y sus ventajas. Se detallan algunos principios quirúrgicos que hay que seguir. Los resultados obtenidos en los casos citados han sido uniformemente satisfactorios. Las fracturas en los alrededores de las articulaciones del codo, la rodilla y el tobillo se prestan particularmente al empleo del método descrito, con relativamente poca manipulación quirúrgica, inmediata movilización y resultados finales superiores. Este método es preferible al empleo de la fijación con placa o con suturas no absorbibles. En virtud de la escasa cantidad de tejidos blandos en las articulaciones anteriormente mencionadas, puede utilizarse con facilidad y gran utilidad la fluoroscopía, mediante la cual se obtiene una visualización fácil y exacta. El uso de tornillos de metal inerte evita la presencia de reacción tisular.

Свод

Дана серия случаев переломов, а также фотографии, показывающие фиксацию винтом, и описание методики и ее преимущества. Подчеркивается легкость введения винта. Указана необходимость следования определенным механическим и хирургическим принципам. Результаты во всех случаях были единообразно хороши. Этот способ особенно применим при переломах коленного, локтевого и голенно-ступного суставов, так как со сравнительно небольшим хирургическим вмешательством он дает немедленную мобилизацию и хорошие конечные результаты. Фиксация винтом предпочитается фиксации пластинкой или неабсорпционными швами. Благодаря небольшому количеству мягких тканей в этих областях, флуороскопия очень полезна, так как она дает легкую и точную визуализацию. Применение инертных металлических винтов предотвращает реакцию тканей.

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Congenital Dislocation of the Hip

Fifty Year Survey

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THE passage of 50 years since the discovery of bloodless reduction of the congenitally dislocated hip (1895) justifies us in again turning the spotlight on one of the most valuable possessions of our art; a therapeutic device to which each year, thousands of children all over the world owe their delivery from permanent crippling.

EARLIER HISTORY

As with so many other clinical pictures, our knowledge of this ailment can be traced back to Hippocrates.[1] From him originated the first classic description of the condition with all its distinguishing characteristics, such as the distortion of the hip, the pathologic gait, the exaggerated lordosis, etc. However, his prognosis in this "luxation of early childhood" seemed extremely unfavorable since he considered its victims suited only for a sedentary life. In the succeeding centuries, the problem of congenital hip dislocation received little or no attention; it was taken for granted that the condition was incurable.

It was not until 1826 that Dupuytren,[2] in an excellent treatise, presented a comprehensive picture of this ailment, not merely from an anatomical-pathologic, but also from a clinical and therapeutic point of view. His influence, however, was hardly encouraging, since he denied any possibility of cure and deplored any attempt at treatment.

Nevertheless, the ensuing years saw earnest efforts at conquering this problem of dislocated hip. And so we see in the late eighteen thirties, Humbert and Jaquier[3] appearing with a new plan of treatment. They claimed that they were able to effect an "immediate" reduction and to maintain the head in the socket. To achieve his goal, Humbert employed forcible *instrumental* extension. By means of this device Humbert endeavored to effect reduction in an 11 year old girl at *one* sitting. When one bears in mind the prevailing technical equipment, especially the absence of anesthesia, it is not surprising that his report met with general skepticism.

While we cannot deny Humbert recognition as the originator of the idea of radical treatment, we are indebted to Pravaz[4] for being the first to have achieved an actually successful reduction by his *gradual* method. He subjected his patients to an 8 to 10 month period of traction, which even now can be considered as standard. As soon as the femoral head descended to the acetabular level, he would start the actual reduction maneuver. This consisted in exaggerated extension, while the limb was simultaneously abducted and pressure directed medially against the trochanter. This maneuver was repeated anew each day with inexhaustible patience until reduction was finally accomplished. Then he tried to maintain reduction permanently by the use of continuous pressure against the trochanter with a Pelotte (pressure pad). The glory of being the first to achieve an actual reduction belongs incontestably to Pravaz. Still his beautiful im-

mediate results were lost because of inadequate retention.

The introduction of anesthesia (1848), had no influence whatsoever on the development of treatment. Attempts by American orthopedists such as Sayre,[5] Bradford,[6] Phelps,[7] Taylor,[8] Ridlon,[9] and others, to revive the Pravaz method, likewise met with little success.

In seeking to explain the complete failure of every attempt at treatment in those days, one sees that one of the primary causes was the fact that, for some inconceivable reason, they selected late cases. It might have been that they were reluctant to expose infants to operative treatment, or, what was more likely, that the condition was simply unrecognized in infancy. Another, no less significant cause for failure, lay in the entirely unsatisfactory methods of *maintaining* reduction, so that even a successful reduction was rendered illusory.

It was only in the eighteen eighties that a more active interest in operative therapy set in. In 1888 Poggi,[10] at open operation succeeded for the first time in reducing the head and maintaining it in a surgically deepened socket. This attempt however, remained an isolated and unrecognized one. Hoffa,[11] followed up Poggi's work and obtained a series of excellent results. Lorenz,[12] improved on the method by contributing a more suitable surgical approach. The Hoffa-Lorenz method persisted for a time as the preferred one. Nevertheless, because of the hazards involved, it did not enjoy general acceptance.

In 1895, setting out with his experiences in open reduction, Lorenz[13] established a new, decidedly conservative basis for treatment. His program involved a complete separation of the two objectives to be fulfilled, namely, *reduction* and *retention*. Insofar as reduction was concerned, this was undertaken at one sitting under general anesthesia by means of a definite maneuver.

To retain it, he conceived the notion of fixing the hip for a specific and prolonged period in a carefully chosen "primary position" by forcibly maintaining the head in its normal location. Further development of the socket would be favored in a sort of functional adaptation, so that even when the limb resumed its natural position, reduction would remain permanent.

Just how little credence Lorenz's concept enjoyed with his contemporaries can be seen in the unfavorable reference of Von Bergmann who explicitly mentions Lorenz[14] in his biography. Von Bergmann, a petty dictator occupying the throne of surgery in the Germany of those days, ridiculed Lorenz's discovery and asserted that it was childish to assume that a socket could appear where none existed and that a stable joint could develop. Just how far from the truth Von Bergmann was in his assertion, was demonstrated in later years by the brilliant results obtained. Few medical achievements have enjoyed more complete vindication. And if these were insufficient proof in the pre-roentgen era, then surely the study of post-mortem specimens, when available, should have taught the opposition that if a socket could develop at an abnormal site, how much more likely was it for one to occur at the physiologic site.

Even later there were sharp attacks challenging Lorenz's contribution and attempts to prove that Paci,[15] was the real discoverer of the method. A chauvinistic controversy raged, and its sponsors tried to designate this as the Italian method. Actually however, Paci, in complete ignorance of the underlying pathologic anatomy, had merely succeeded in

improving the position by his methods —a result which many had already achieved. At the same time he completely overlooked the really important and entirely original part of Lorenz's method—that is retention (or maintenance of reduction). Regardless of the method of approach, the fact remains that only with the accomplishment of successful retention, did the conservative reduction of congenital dislocation acquire a permanent place in treatment. In any event, it is remarkable that an ailment recognized for over 2000 years, did not have a generally accepted method of proper treatment until 50 years ago.

DEVELOPMENT OF TREATMENT IN THE LAST 50 YEARS

Specialists everywhere have been intensely concerned with this problem for the past 50 years. An enormous literature on the subject attests to the enthusiasm with which it has been attacked. A discovery of such importance in the care of the crippled, excited great interest not only in orthopedic practice, but to the general practitioner as well.

The most valuable investigation during this period were the *pathologic-anatomical* studies which substantially advanced our knowledge of the cause and development of luxation. Originally there were two concepts on *etiology;* the *mechanistic theory,* which looked upon the dislocation as a result of intrauterine compression; and the theory of *primary defect* in development, entirely independent of mechanical influences. In support of the latter interpretation there is the factor of heredity, manifested in about 20 per cent of all cases. According to the current concept, apart from the rare teratologic or arthrogrypotic malformation, congenital dislocation of the hip is not truly congenital. The only congenital factor is the tendency to dislocation in the shape of a *dysplasia.* That is to say, there is a disturbance in development or growth of bone structure in the region of the acetabulum, which leads to a thickening of the osteoid tissue forming the floor of the acetabulum and therewith to a flattening of the socket. The dislocation as such, is a secondary affair, which develops gradually as an effect of muscle action, or under the influence of weight bearing toward the end of the first or second year. The cause for the disturbance in bony growth remains, of course, obscure, as does also the moot question of the predisposition of females to be affected (6 to 1). So far, all investigation seeking to establish the cause in an anatomical variation of the pelvis, demonstrable in the foetus, has failed.

Numerous disappointments in end results which failed of absolute anatomical correction, led of necessity to a revision of our concept of cure. Whereas operative results were previously evaluated primarily from a *functional* viewpoint, and a patient considered cured when he had a normal gait—i.e., no limp, absence of pain and fatigability—later follow-up roentgen studies of cases reduced years before, demonstrated that the prognosis of bloodless reduction had been reported too favorably as to *anatomical* recovery. Postoperative alterations in the caput appearing soon after the conclusion of treatment would appreciably influence the result. One of the main reasons for this, in the writer's opinion, is the disproportionate rate of growth between head and acetabulum which reaches its peak at puberty and leads to subluxation and secondary incongruity of the opposing joint surfaces and thence to osteoarthritis. To these, may be added the numerous cases

of Perthes' disease, coxa plana, coxa vara, etc., changes to be sure, against which nonluxated joints are uninsured, but which, nevertheless, are much more common in reduced hips.

One is inclined, therefore, to consider as satisfactory end-results only those cases which have been followed ten years or more after reduction, and to consider as "cured" only those cases which are anatomically normal on roentgenographic examination. Under such rigid standards, one can count on an average of *50 per cent of cures anatomically and functionally.* Extensive statistics covering more than 1000 cases, such as those of Poli [16] in Italy and M. Lange [17] in Germany show that the results are most favorable in cases reduced in the first or second year (up to 63.7 per cent). After the third year the results get poorer, and after five, good end results are rare indeed. The upper limit for bloodless reduction in unilateral cases is generally accepted as six years and for bilateral as five. Beyond these age limits, the difficulties increase rapidly and soon become insurmountable. To begin with, the long standing contracture of soft parts and adhesions between capsule and ilium, or capsule and head make reduction practically impossible. Besides this, the result finally ends in failure because of the defective development of the acetabulum, which at the end of the second growth period (sixth to seventh year), has already completed its form, and is incapable of further development. In addition, there are other dangers of forcible reduction in advanced years—above all, damage to the sciatic nerve. Actually the author has succeeded, in individually selected cases, following proper preliminary preparation, in achieving excellent results without mishap, in children of 8 and 10 and once in a girl of 12. These, of course, are exceptions which prove the rule. It is obvious from these brief observations how vital early diagnosis is for proper treatment of congenital dislocation, and it should be considered unforgivable when, either through ignorance or carelessness, the favorable period for treatment is allowed to pass!

The *technique* of bloodless reduction has not changed essentially in the course of five decades. Reduction is effected over the posterior rim of the acetabulum and articulation occurs in three phases, flexion, abduction and implantation. It is accomplished manually, and in older cases and in those with a high iliac position of the femoral head, follows employment of skin or skeletal traction. The manipulation must be extremely gentle, every undue force being avoided. There is no doubt that a great deal of postoperative osteochondritis can be traced to the trauma of reduction.

We still insist on the fixation in the "primary" position, characterized by right angled flexion and abduction, since it affords the greatest insurance of stability. It is easy to convince oneself of this, for one has only to deviate by the slightest degree from the extremely abducted or flexed position, and the head immediately redislocates over the upper or posterior rim of the acetabulum. In our opinion the "primary" position should actually be *accentuated,* that is, abduction be increased beyond the horizontal, a position which may be called *negative* abduction, in order to obtain the deepest possible insertion of the head in the acetabulum, thus sparing the rim of the acetabulum as well as the head from any continuous pressure. An accurately fitting plaster of paris spica is applied in this attitude hugging the pelvis and femur, leaving the knee free however, to encourage function and the

stimulating influence of the muscles acting on the hip joint. The fixation period is continued for from 6 to 9 months, depending on the primary stability and roentgen-ray findings. Following this, a posterior shell is fashioned, in which the child remains at night. No force should be exerted to bring the hip down from the abducted position as this is best accomplished gradually by the natural efforts of the child. The most important point to be observed is that the primary position must be maintained *without interruption* until the end of the plaster treatment period. We emphatically disapprove of any alteration of this position into a "second" or "third" position by forcefully reducing flexion and abduction, except in unusual cases. Fear of persistent abduction contracture is unfounded. In more than 1000 cases which we reduced, in the favored age group, we never encountered difficulty in bringing the limbs down into the parallel position. We maintain, on the contrary, that the forced internal rotation of the so-called second position, and the continual pressure of the still undeveloped capital epiphysis against the acetabulum is one of the chief causes for osteochronditis, coxa plana, coxa vara and other complications.

As to the later aftercare, the treatment has been altered so that instead of the functional weight bearing of Lorenz, which it was hoped would provide gradual deepening of the rudimentary acetabulum, we prefer the stimulating effect of *motion and exercise.* Weight bearing is allowed only if the roentgenogram shows a satisfactory development of the acetabulum.

When bloodless reduction fails, as in older children, *open* procedures may be considered. In our opinion this should be restricted to freeing the capsular constriction or its adherence to the ileum or to the head or the acetabulum. Should the ligamentum teres be thickened and enlarged, it is removed. Instead of artificially deepening the acetabulum by removal of the cartilage which constitutes the floor, we favor the *acetabular roof plastic (shelf) operation* of Lance.[18] This should not, however, be undertaken before the age of six since the new roof readily undergoes resorption. Even operative reduction has its age limits, the majority of surgeons agreeing that no surgery should be employed after ten. Shortening is usually too extreme, the head and fossa, in most cases, too deformed and degenerated to promise a satisfactory result.

There remains one more question; what is to be done with those patients who have exceeded the age limits for favourable reduction, bloodless or otherwise? Heretofore these cases were considered incurable, and treatment was limited merely to palliative methods such as belts or supports. Lorenz[19] found a happy solution for these as well. Since the head could no longer be reduced, it was left in its pathologic site, and a subtrochanteric osteotomy performed with the upper end of the distal fragment placed in the acetabulum ("bifurcation"). By this means, the femur by-passes the acetabulum and the pelvis obtains its bony support at the physiologic site. I[20] have modified this procedure, in that after performing a subtrochanteric osteotomy, the *lesser trochanter* is placed in the acetabulum. Because of its smooth round contours, the lesser trochanter is peculiarly adapted to serve as a substitute for the femoral head, and insures painless weight bearing with maximum mobility. Of course, subtrochanteric osteotomy is no more than a palliative measure, but the functional improvement obtained

merits its consideration along with radical methods. With the addition of this operation for old unreduced cases, our therapeutic armamentarium seems to be definitely complete; the structure erected under such favorable auspices 50 years before, is finally crowned with success.

PRESENT STATUS OF TREATMENT

Reviewing the present attitude toward treatment, one notes, in spite of the enormous amount of work done, little unanimity as to the best method to be adopted. Thus, while some orthopedists are inclined to favor open reduction, others are convinced that closed reduction should be given preference reserving surgery for those cases in which closed reduction has failed. It should be recalled however, that open reduction as mentioned above, was the prevailing one prior to 50 years ago, and that when it was dropped in favor of bloodless reduction, it was primarily because of the risk inherent in all operative surgery of that time. Even with the reduction of these factors to a minimum under today's advances in asepsis and surgical technic, there is no denying that bloodless reduction is essentially less hazardous. Another point in its favor is the marked tendency to contracture and ankylosis following open reduction, due to extensive surgical exposure and damage to the capsule. Last, but by no means least, there remains the fact that the results in closed reduction surpass those by the open method. Even as enthusiastic a supporter of operative reduction as Kidner,[21] conceded that the only really completely satisfactory results among his cases were in the closed group.

Final judgment will indeed have to depend on larger groups for comparative analysis of open as against results of closed reduction and these are not yet available. Until then, bloodless reduction remains the ideal method since it gives results within normal age limits which are unattainable by other means. It is to be hoped that, in the future, with more careful recognition of the proper age for accomplishing bloodless reduction (i.e., one to two years), still fewer cases will be treated by open reduction.

The existence of a "predislocation" during the first year of life, opens up the possibility of effective *prophylaxis* and Putti[22] states that in his clinic in Bologna, in a series of 119 cases, under twelve months of age, complete cure was obtained in 113 (that is, in 94.9 per cent), by Putti's method of maintaining the hip in abduction of 45 degree and internal rotation, by means of a metal splint. Putti insisted upon an extremely thorough examination of the hips of every newborn infant, but as Campbell[23] rightly observed, such an overall rule would be justified only in certain Italian provinces where, according to Poli,[16] the incidence of dislocation reached 1.9 per cent of the population. In the U. S. where the condition is so rare, this would hardly seem reasonable. Nevertheless much could be accomplished by further enlightment of infant nurses, attendants at baby health stations and above all of the general practitioner, so that as soon as an infant presented signs even slightly suspicious of luxation, such as asymetry, flabbiness, external rotation and limitation of abduction, routine roentgen examination would be undertaken.

SOMMAIRE

L'étude couvre la période depuis 1895, l'année de l'introduction par Lorenz du traitement conservateur de cette lésion. La valeur relative du traitement opératoire et du traitement nonopéra-

toir pratiqués durant les derniéres cinquante années est discutée, et les resultats et le pour centage de succèss comparaient. La fixation et le maintien de la position primaire durant six ou neuf mois de las méthode conservatrice est de rigueur. Les causes et les moyens de prévenir la complications sont mentionnés. L'âge est un facteur important dans le choix des procédés à employer chez les malades d'un âge avancé. Las possibilitée de prophylaxie durant le première année et aussi la nécessité d'un meilleur enseignement pour les infirmières d'enfants et pour le personnel des pouponnières sont affirmées avec emphase.

RESUMEN

En éste artículo se pasa revista a las primeras descripciones e intentos de tratamiento de la dislocación congénita de la cadera, llegando en el estudio hasta los ensayos iniciales en el año de 1895, en el que Lorenz introdujo el nuevo método conservador de tratamiento. Se discute el valor relativo de los procedimientos abiertos y sin sangre empleados durante los cincuenta años transcurridos, comparando los resultados y porcentajes de éxito. Se realza aquí la importancia de mantener la posición "primaria" con espica a seguidas de la reducción sin sangre, a traves de todo el período de fijación de seis a nueve meses. Se relatan las causas y el modo de prevenir las complicaciones. El factor edad se tiene bien presente conjuntamente con los métodos a emplear en los pacientes ancianos. Se ponen de manifiesto las posibilidades de la profilaxis durante el primer año y asimismo se señala la conveniencia de una mejor instrucción a las enfermeras y encargadas del cuidado de los niños en las instituciones sanitarias infantiles.

Свод

Дан обзор прежних описаний и попыток лечения прирожденного вывиха бедра до 1895 года, когда Лоренц ввел свою новую консервативную методу лечения. Дана сравнительная оценка открытого и безкровного способов за эти последние 50 лет, а также статистика результатов и успешных случаев. Подчеркнута необходимость сохранения после безкровной редукции первичного положения при помощи колосовой гипсовой повязки в течении всех 6—9 месяцев фиксации. Даны возможные причины осложнений и их предотвращение. Указана возможность профилактики в первый год жизни, а также необходимость лучшей подготовки вторичного персонала станций младенческого здравоохранения.

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Patella Fracture—A Method of Treatment

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FRACTURES of the patella comprise between 1 and 2 per cent of all fractures;[1] a small and rather neglected group. Functional results have not been as good as one could wish.[3] The many methods of treatment have been confusing and often not practical.[2] The following method is described for the reason that it does seem practical.

The patella is a spongy sesamoid bone which usually makes its appearance roentgenologically in the third or fourth year of life and is formed in the quadriceps tendon, becoming fully developed about the eighteenth year.[1, 2] It functions as a protection to the knee joint[2] and is therefore important especially to those who may have to kneel. Cosmetic results may also need to be considered.

There are two types of fracture and two usual causes, direct and indirect force, the former being by far the more common. The most usual cause is violent contact with the instrument board of a motor car. Types are: the rather rare form, the stellate fracture; and the far more common type, the transverse fracture, as illustrated.

There have been two general forms of treatment, the conservative splint (or cast) method and the operative. Both have given varying and somewhat unpredictable results.[3, 4] Many kinds of material especially sutures have been used in the operative treatment, such as catgut, silver and iron wire, kangaroo tendon, and fascia.[4] The postoperative treatment has been just as indefinite. "There has been no general agreement."[4] There has, however, been almost universal agreement on one point, which is that repair of the torn fascia is all important.[4, 5] Nature will accomplish this if the edges are brought and held together without intervention of foreign materials.

Recently, the trend has been to remove the patella in part, or completely, and to suture the rent fascia.

The method described has appeared good to me because it is simple and easy. It requires no elaborate operating room. A simple anesthetic can be used. One assistant is sufficient. The joint proper is not invaded. Finally, results in the few cases in which this method has been used, have been most satisfactory.

If the skin is broken, a thorough cleansing, with debridement, is done, preferably with the aid of anesthesia, and the surrounding skin is widely cleansed and painted with antiseptic. Superficial repair is done when necessary, and a sulfonamide crystal preparation inserted. A sulfonamide compound should usually be given by mouth for a few days, also, and antitetanus and anti-gas-gangrene prophylaxis is usually indicated. Penicillin or some other antibiotic may be desirable. The only instruments needed are three metal pins (one for a spare), a drill with which to insert them, two or three hemostats for handling the pins, a sharp-pointed knife, some sterile sponges, gloves, gowns and drapes. Possibly, a sterile syringe and needles and a local anesthetic solution may also be needed if it is desired to use local anesthesia. Intravenously administered pentothal sodium is also satisfactory.

The assistant holds the fractured patella in place with his thumbs and forefingers (see illustration, fig. 1 *A*).

If it has been decided to use local anesthesia, the anesthetic may then be injected down to the bone at the four sites indicated in the diagram (fig. 1 *B*).

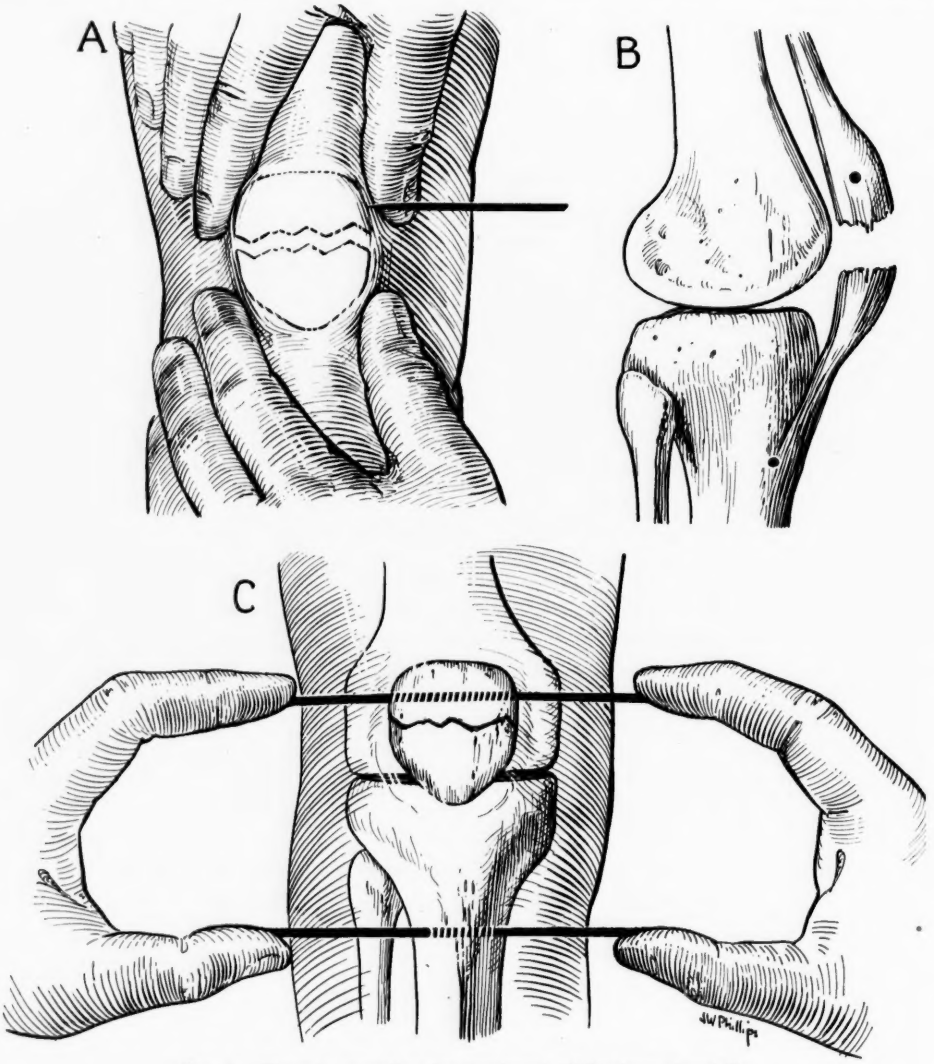

Fig. 1.—Steps in operation for treatment of fracture of patella.

With the assistant holding the upper fragment firmly, a small incision is made at the upper lateral angle so that the pin can readily be drilled horizontally, transversely through the bone; the skin is again nicked when the point of the pin projects on the opposite side. The lower pin is more easily inserted deep to the tibial tuberosity. Sterile gauze sponges (usually two) are put over the four ends of the pins, which are allowed to project about 2 cm. The

assistant now draws the pins firmly toward each other, bringing the patella fragments into close apposition (fig. 1 *C*), and the fragments are moulded into position by direct pressure against the femoral condyles.[6] A narrow, fast-setting plaster of paris bandage is next applied around the pin ends, vertically on each side and diagonally superficially, to hold the fragments firmly in position. The ends of the pins can also be covered with this bandage. Elastic could probably be used instead. I have used a light, short cast, but I believe this could be eliminated and the patient allowed to be freely ambulatory with cane or crutches. I leave the cast on for about six weeks,[4] at which time the pins are usually easily withdrawn (with antiseptic precautions). After this, a light posterior splint may be desirable and physical therapy may be used.[4, 5]

The case represented by the roentgenograms was the most recent. The patient was a woman of 60, overweight and diabetic, who was injured in an automobile accident.

She suffered injuries about the head and face, a comminuted fracture above the right ankle and a fracture of the left patella. She was in bed at the time the patella was treated. Both preliminary casts were removed about the same time, and she was allowed to be up on crutches. The functional and cosmetic results are excellent.

Fig. 2.—*A* Aug. 1, 1944; *B* July 3; *C* June 5, 1944, and *D* May 12, 1945 (*A* and *C* accidentaly reversed; note dates)

SUMMARY

A method of treating fracture of the patella by insertion of two small pins is offered. It has the advantage of being readily accomplished without elaborate facilities or equipment. The joint proper is not invaded, and no bulky foreign material is introduced into it. The results appear superior to those heretofore obtained. Roentgenographic checks after insertion of pins, as well as before their removal, are advised.

SOMMAIRE

Une méthode de traiter ces fractures par l'insertion de deux petites épingles offre l'avantage de pouvoir être accomplie facilement et sans outillages compliqués. L'articulation n'est pas envahie. Aucun matérial n'est introduit dans l'articulation et les résultats sont supérieurs à ceux obtenus par des méthodes compliquées. L'auteur recommande le contrôle radiographique de la jointure après l'introduction des épingles et aussi après leur enlèvement.

RESUMEN

El autor describe un método para el tratamiento de las fracturas de la rótula, mediante la inserción de dos pequeñas agujas. El procedimiento tiene la ventaja de ser facilmente realizable sin que haga falta para ello ventajas especiales o un material complicado. No se invade la articulación propiamente dicha, ni se introduce en ella ningun material extraño voluminoso, obteniéndose de este modo resultados que parecen ser superiores a los hasta la fecha conseguidos. Es recomendable la comprobación radiológica antes de la inserción de las agujas y después de quitarlas.

Свод

Предложен способ лечения коленно-чашечных переломов посредством введения двух небольших булавок. Он имеет то преимущество, что его легко применить, и сложная аппаратура не нужна. Самый сустав не вторгнут. Об'ем постороннего материала небольшой, а поэтому результаты лучше, чем достигнутые до сих пор. Советуется рентгеновская проверка как после введения, так и до удаления булавок.

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therapy is recommended and our results were favorable in this respect.

The use of roentgen-ray therapy alone has its great disadvantages, and the method of choice in the treatment of bone cysts and giant cell tumors is surgery.

Spontaneous fractures do not, as a rule, promote healing in giant cell tumors.

From a pathogenetic, roentgenologic and clinical viewpoint, a distinction between bone cysts and giant cell tumors is inadvisable and, in consequence, therapy should follow the same lines in both conditions.

SOMMAIRE

Quince cas de tumeurs de cellules géantes sont rapportés. Quatorze cas furent opérés. Les résultats furent satisfaisants dans treize cas; deux cas sont encore en observation. L'excision ou la résection avec greffage dós est préferable au curettage. Le curettage favorise les recidives. La X-rayon therapie pre-opératoire a peu d'influence. Après l'opération, les auteurs la préconise. Les fractures spontanées ne paraissent pas favoriser la guérison de ces tumeurs. En fait de traitement il ne faut faire aucune distinction entre les kystes osseux et les tumeursà cellules géantes.

RESUMEN

Se describen aquí quince casos de tumores de células gigantes. En 14 de estos casos la terapéutica consistió en la intervención quirúrgica. Los resultadosobtenidos fueron favorables en todos los casos excepto en dos que continuan en observación. Debe preferirse la excisión o resección con injerto óseo en lugar del curetaje que parece favorecer las recidivas en mayor escala. La roentgenoterapia realizada antes de la operación parece tener muy poco efecto, pero es recomendable llevarla a cabo postoperatoriamente. Usada sola es desventajosa. Las fracturas espontáneas no parecen provocar la aceleración del proceso curativo de los mencionados tumores. No es aconsejable el establecer, desde el punto de vista del tratamiento, diferencia alguna entre los quistes óseos y los tumores de células gigantes.

Свод

Описаны 15 случаев гигантско-клеточной опухоли. 14 случаев были оперированы с удовлетворительными результатами, за исключением двух случаев, которые еще находятся под наблюдением. Так как выскребывание благоприятствует рецедивам, то предпочитается иссечение и резекция с костным трансплантатом. Рентгенотерапия до операции эффекта не имеет. После операции она советуется. Без операции она, как будто, приносит вред. Спонтанные переломы не содействуют вылечению этих опухолей. Советуется не делать различия между лечением костных кист и гигантско-клеточных опухолей.

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ACKNOWLEDGMENT

Thanks are due for their unfailing cooperation and advice to Prof. Halberstaedter (Radium Department), Dr. Druckmann (Diagnostic X-ray Department) and Prof. Franco (Institute of Pathology) for the microscopical examinations.

NEW BOOKS

Daniel P. Quiring's new book, **The Extremities,**[1] while intended as a student text, should also prove valuable to anyone who feels the need for a refresher in some of the fundamentals of anatomy. Small and light, containing little more than one hundred pages, it nevertheless yields a wealth of information, so arranged as to be instantly available. The upper half of each page carries a clear line drawing with a few landmarks indicated. Below are listed in tabular form, the origin, insertion, and function of the muscle represented, the names of the chief nerve and artery, and ten or a dozen references to Grey and Cunningham, for those who need more detailed information. Both index and table of contents are printed in large, bold-face type, to expedite still further the finding of a needed subject.

In a small, paper-bound handbook, the **American Red Cross** offers a revised edition of its **First Aid Textbook.**[2] Though primarily intended for the layman, this work will also be a useful adjunct to the physician's library. First aid has become much more generaly understood during the war years, due to the training given not only to men and women in the uniformed services, but also to great numbers of those who remained on the home front. Nevertheless, details are easily forgotten. Having handy a good book on the subject will give confidence when one *is* called upon to help out in an emergency. Such the Red Cross, with its wealth of experience, has provided.

The problem of the facial cripple is one which, because of its psychological and economic aspects, has challenged man's ingenuity for centuries. **Arthur H. Bulbulian,** in his **Facial Prosthesis,**[3] states that "artificial ears, noses and eyes have been found on Egyptian mummies." While this new book is chiefly a manual on the actual making of replacement parts for damaged faces, the author has been constantly conscious of the human mind and heart behind the disfigurement. To the specialist-technician, it should prove a valuable guide; to the general practitioner, who, today, more than ever before, because of the return of casualties who would have died in earlier wars, is faced with an appreciable number of these formerly unusual patients, it should be an inspiration. In physical format, the book is attractive, small and light in the hand, profusely illustrated with remarkably large, sharp photographs and drawings, and—a feature too often neglected—will lie open on the work-table or desk without the need of a weight.

Many persons, even including many within the medical profession itself, fail entirely to realize that the physician's practice is also **The Physician's Business.**[4] **Dr. George D. Wolf** has written his book on the business side of medical practice in recognition of the fact that the doctor, is "not in business for his health"—even though plenty of his patients seem to think so!

This second edition of a book first copyrighted in 1938, takes particular note of the new trends, fostered by the war and the resulting changes in our economic outlook. He deals especially with the prospects for socialization of medicine, and compulsory health insurance plans.

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[1] The Extremities. Daniel P. Quiring, Beatrice A. Boyle, Erna L. Boroush, Bernardine Lufkin. 117 pp., 106 engravings. Lea & Febiger, Phila., 1945. Price $2.75.

[2] American Red Cross First Aid Textbook. Revised edition. 254 pp., 264 illustrations. The Blakiston Co., Phila., 1945.

[3] Facial Prosthesis. Arthur H. Bulbulian. 241 pp., 202 illustrations. W. B. Saunders Company, Phila., 1945.

[4] The Physician's Business. George D. Wolf, M.D. 2nd ed. 433 pp., 58 illustrations in the text. J. B. Lippincott Co., Phila., 1945. Price, $6.00.

A partial list of chapter headings give an idea of the very wide scope of the book. Included are sections on interneship, careers other than private practice, specialization, location, the office and its management and equipment, forensic medicine, prepayment insurance and workmen's compensation laws; also many examples of charts and office forms, office floor plans and lists of instruments and equipment. A section on what the office nurse may and may not do, when left on her own responsibility, is included. In all particulars the author has been specific. A comprehensive bibliography, subdivided according to general subject, is placed at the end of each chapter.

This **Atlas of Surgical Approaches to Bones and Joints,**[5] is, in format, much like a geographical atlas. Large pages and clear, beautifully-detailed drawings, without unnecessary or confusing lines—these, the handiwork of the author, **Dr. Toufick Nicola,** himself—make this a guide to objectives within the human structure, in precisely the way that a mariner's atlas guides him over the trackless wastes of the sea.

The individual diagrams occupy, in most cases, the upper three-quarters of each page, with a few brief, concise "navigational directions" below. The text is divided into five general parts, shoulder girdle, upper extremity, trunk, lower extremity and skull. Within these, subdivisions cover each main anatomical feature separately and quite thoroughly, except for the section on the skull, which seems a little too brief.

The author makes no attempt to outline or even suggest, actual surgical technics, by which token this book should prove of more *continuing* value than many more pretentious works. Technics change; anatomy does not. Dr. Nicola's many years' experience as a specialist in orthopedic surgery, gives him the wisdom to strengthen by omission—whence much of the value of this book to the active, busy surgeon, to whose assistance it is dedicated.

[5] Atlas of Surgical Approaches to Bones and Joints. Toufick Nicola, M.D., F.A.C.S., Professor of Orthopedics, New York Polyclinic Medical School and Hospital, with a foreword by Norman T. Kirk, Major General, U. S. Army, The Surgeon General. 218 pp. The Macmillan Co., New York, 1945. Price, $5.00.

Authors planning to submit papers to the *Journal* for publication, should be sure to read the "General Information" page, for NEW editorial requirements.

Nous prions les auteurs désireux de soumettre des articles destinés a être publiés dans le "Journal of the International College of Surgeons" de relire attentivement les recommandations publiées sous la rubrique "General Information" page.

Los autores que dessen enviar artículos para su publicación en el *Journal*, deben consultar la página de ésta revista dedicada a "Información General", para conocer los NUEVOS requerimientos editoriales.

Авторы, намеревающиеся послать статьи для публикации в Журнале, должны обязательно прочитать страницу общих сведений (General Information), дающую новые редакторские требования.

Sección en Español

Un Gran Luchador: Albee

EN la pequeña aldea de Alna, Maine, apenas visible en el mapa de América, vino a la vida, el 13 de abril de 1876, una criatura que, andando el tiempo, llegaría a ser uno de los más preclaros cirujanos de nuestro tiempo. Su nombre fué Fred. H. Albee. En la probeza de la granja paterna discurrieron sus primeros días, alimentados ya por la fortaleza, la energía y la fé que iban a rubricar toda su existencia. Todavía entonces está obscuro e incierto el provenir, aun no ha descubierto el rumbo que ha de imprimir a su vida, pero ya la curiosidad y el entusiasmo le alientan en la dura senda que va a emprender.

Nacido de una familia de marinos y agricultores, tiene los ojos abiertos a lo imprevisto y el corazón preparado para la lucha que va a empezar muy pronto. Al lado de su abuelo Houdlette comienza a adquirir conciencia de su vocación, al contemplar con sus ojos de niño los injertos que sobre árboles y árboles va haciendo el buen viejo. Esta fué quizas su primera lección en lo que más tarde habría de constituir la pasión de su vida. Luego vinieron otros aprendizajes y experiencias más importantes: la escuela, la universidad y los hospitales. Paso a paso, con una fé inquebrantable y una energía indecible, va enriqueciendo su mente con nuevos conocimientos y renovados experimentos. El trabajo es para Albee como una necesidad imperiosa a la que se entrega sin reservas. Sus años de estudiante y sus primeros días de médico están caracterizados, precisamente, por un infatigable laborar que apenas le deja tiempo para ninguna otra cosa.

Así pudo éste hombre singular llegar a la meta de sus nobles ambiciones, porque no se acobardó ante el consabido "eso no lo ha hecho nadie todavía", que a tantos otros cierra el paso; pero Albee puso al servicio del ideal su energía, su habilidad, sus conocimientos y su imaginación, para llegar a ser, como él mismo dice, "todo un hombre".

Su característica esencial fué la lucha, la lucha sin tregua y sin desmayo a través de toda su existencia convirtiéndose de éste modo en el precursor de un nuevo sistema. De que era un luchador tenía Albee plena conciencia. Véase si no sus propias palabras: "Toda mi vida he sido un luchador. No recomiendo a nadie ésta clase de vida como fácil, pero si la garantizo como una existencia llena de contenido."

Durante su internado, Albee entra en contacto directo con el dolor y la muerte y como reacción lógica nace en la conciencia del luchador el ímpetu y la decisión de vencer a ambos con nuevas armas más adecuadas para el combate. De ésta forma y tras renovadas experiencias llega por fín a la aplicación práctica de su método de los injertos óseos en la columna vertebral. Después

de él, y siguiendo sus huellas, otros han aportado tambien su grano de arena, pero a Albee se debe el arranque inicial de una técnica que habría de revolucionar la cirugía.

Desde los tiempos heroicos de la medicina en América, que habría de verse aupada al rango de gran ciencia con los nombres de John Morgan, Benjamin Rush, Ephraim McDowell, Daniel Drake, William Beaumont, Crawford W. Long, William T. G. Morton y tantos otros, quizá ningun hombre haya contribuido más al adelanto de la cirugía como lo hizo Fred Albee.

Tuvo Albee, entre otras, tres grandes virtudes: la actitud crítica de Paracelso, la capacidad observadora de Vesalio y el impulso experimentador de Paré. Todas ellas las usó con largueza y no escatimó sacrificios en el duro camino que había elegido. Aun hay más, y es que éste hombre infatigable nunca se amilanó ante la duda y escogió, entre todas, su propia opinión. He aquí, a mi juicio, la clave de su triunfo: el pensar y actuar por cuenta propia, despreciando el concepto arcaico de que la ciencia destruye la personalidad, haciendo de ella un mero número. Por encima de todo estaba el beneficio de la humanidad desvalida, todo lo demas fué pura anécdota para Albee. Gracias a ello miles de vidas se han salvado y aun mayor número de miembros han escapado a la amputación.

Su sentido social corría parejo a su actitud científica dando perfecto equilibrio a su mente abierta a los principios más liberales y democráticos. De ésta forma, su concepto del mundo como lugar de habitación agradable para el hombre se funda en la justicia y el raciocinio. Ve claro el problema y lo afronta sin ambajes: "No es bastante—dice—el apiadarse de los enfermos y de los mutilados; no es bastante el hacerles caridades. El enfermo y el mutilado son un desperdicio económico y es un contrasentido criminal el apuntar a la vieja ley de la supervivencia de los biendotados y encogerse de hombros. La sociedad misma se halla enferma cuando grandes contingentes de sus miembros son fisicamente incapaces."

Para poner remedio a ese estado de cosas luchó toda su vida, en su país y en muchos otros, alentado por un optimismo incurable, mirando al mismo tiempo hacia el pasado y hacia el porvenir. Es éste optimismo y aquella fé que antes dijimos los que le hicieron exclamar en los días de la segunda Guerra Mundial, tan presente, las siguientes palabras: "Lo que se ha hecho es solo el comienzo. Todavía hay tiempo para más."

Por desgracia a él no le quedó mucho tiempo; el hilo de su vida fué cortado muy pronto. Su existir material se ha extinguido pero su ejemplo, sus enseñanzas, sus virtudes, su entusiasmo y su fé siguen latiendo como un simbólico índice que nos señala, a los que quedamos, el camino a seguir. Adentrémonos por él resueltos y dispuestos a llegar a la meta; si alguien queda atrás no hay qua volver la vista sino apretarse el corazón y seguir.

El Colegio Internacional de Cirujanos que tanto debe a Albee sigue las huellas todavía calientes de su desaparecido Presidente Internacional, teniendo por lema los mismos principios humanitarios y científicos que animaron a aquel hombre en todo momento. En el mundo entero se conoce, respeta y venera el nombre de Fred H. Albee. Con su muerte perdió la ciencia un firme puntal y la humanidad un amigo generoso.

DR. MANUEL MANRIQUE

Tratamiento de las Fracturas Epifisiarias Superiores del Fémur con Injerto Doble*

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UNO de los problemas que ha seguido preocupando hondamente a los Cirujanos es el de las fracturas de la epífisis femoral superior, con especialidad las del cuello, que son las más frecuentes, en su porción conocida como cuello quirúrgico; en la inserción capsular o cuello anatómico y las inter o transtrocantéricas.

En el anciano, en que la osteoporosis viene a aumentar las probabilidades de las fracturas en los puntos débiles del esqueleto, son las fracturas del propio cuello las que predominan. Las intertrocantéricas son más frecuentes en los sujetos jóvenes.

Para comprender mejor las variantes de éstas fracturas epifisiarias, hay necesidad de tener muy en cuenta los rasgos anatómicos principales de la arquitectura ósea femoral y la nutrición sanguínea de la epífisis superior.

La cabeza femoral que termina el macizo del cuello, que es un cilindro aplastado de adelante a atrás, forma con el eje femoral de la diáfisis un ángulo abierto hacia dentro y abajo de 130 grados. El cuello está dirigido hacia arriba, hacia adentro y hacia atrás; nociones éstas, que son indispensables conocer, para inmovilizar la articulación correctamente, lo mismo que para la colocación del enfermo en la mesa ortopédica de operaciones.

Las variantes de ésta inclinación, dan nombres distintos a las posiciones anormales del cuello femoral; así la coxavara, será la cerradura del ángulo antes mencionado a 90 grados y aún menos; la coxa-valga la exageración de la abertura, hasta llegar a veces a los 180 grados.

La nutrición del cuello y cabeza femoral nos explica por qué tan frecuentemente éstas fracturas se complican de falta de consolidación, o pseudoartrosis. La nutrición del cuello y cabeza, es suministrada por las arterias circunflejas anterior y posterior y por la arteriola del ligamento redondo.

En caso de fractura cervical intracapsular, si los fragmentos se desalojan, las arteriolillas que forman una verdadera red anastómotica entre la del ligamento redondo y las ramificaciones de las arterias nutricias suministradas por las circunflejas, se rompen dejando exclusivamente el fragmento interno o cefálico con la única fuente de nutrición, la arteriola del ligamento redondo. Si éste vaso queda intacto después del traumatismo, la cabeza no muere; si por el contrario, el traumatismo la trombosa, o maltrata su túnica interna, vendrá un proceso de rarefacción convirtiéndose en una esfera necrótica aséptica, pero incapaz de unirse con el fragmento externo o trocantérico que conserva intacta su irrigación.

La arquitectura misma del hueso, nos explica por qué las fracturas del cuello ocurren más frecuentemente en determinados lugares de la epífisis. El tejido óseo compacto forma una serie de verdaderas trabéculas que están dispuestas de manera especial; en un corte longitudinal de la epífisis, se puede

* En memoria del gran cirujano Dr. Fred H. Albee.

observar ésta serie de pequeños arcos que tienden a aumentar la resistencia, pero hay lugares en que éstos no existen y son esos lugares presisamente los elegidos por las fracturas, por su menor resistencia.

Las perciones duras y más consistentes de la epífisis presentan dos zonas particularmente resistentes: una interna y otra externa, que forman entre sí una especie de arco ojival que soporta el macizo cefálico, cérvico-trocantérico.

De la porción interna más resistente, se desprende un espolón que se prolonga por la parte ineferor del cuello hasta la cabeza, y constituye su principal apoyo asegurando la rigidez del cuello, como si fuera el asa de un bastón con mango curvo.

La compacta externa se adelgaza y termina en la cara exterior del trocánter mayor. El cuello está autonomamente reforzado por una lámina compacta supra-cervical. En la base del cuello se observa en el corte de un hueso seco de esqueleto de jóven, otro macizo o amarre verticalmente colocado, formando la rayita transversal de una A mayúscula oblicuamente inclinada.

Es en éste dispositivo del tejido óseo de la arquitectura de la epífisis, en la que me fundo, para proponer el doble injerto en forma de ménsula que describiré posteriormente.

Es frecuente, que sea el borde superior del cuello femoral por su menor resistencia el que se fracture en la inmensa mayoría de los casos, y es presisamente éste borde superior, casi transversalmente colocado, el que recibe directamente, con la porción superior del casquete cefálico, el peso del cuerpo a través de la cavidad cotiloidea del ilíaco.

En las fracturas subcapitales o por degollamiento queda el casquete cefálico móvil en todos sentidos y la única atadura, dentro de la cavidad cotiloidea y el manguito capsular, es el ligamento redondo que lleva la delgada arteriola nutricia del hueso.

En los viejos ésta arteria, aún cuando no haya sido traumatizada al producirse la fractura puede obstruirse por la arteriosclerosis y, entonces, se produce la necrosis aséptica de que hablé antes.

Se añade a esto, que en las fracturas cervicales intra o extra capsulares, lo mismo que en las inter-trocantéricas, el fémur sufre una rotación externa que sapara en ángulo diedro, abierto hacia adelante, los fragmentos; al mismo tiempo, la tonicidad de los músculos pelvitrocantéricos y el ilíaco, hace que el fragmento externo, trocantérico, suba, quedando entonces una coxa-vara traumática que acorta el miembro inferior algunos centímetros, constituyendo con la rotación externa los sígnos patognomónicos de la fractura.

Teniendo en cuenta éstos factores, he tomado de ellos base para asegurar que un gran número de fracasos y de no consolidación, aún en personas jóvenes no operadas, se deben a que sólo se hace tracción directa y no se imprime al miembro la rotación interna exagerada, que producirá la aposición exacta de las superficies de fractura.

Cuando se exagera la rotación interna se pone tensa la cara posterior de la cápsula, lo que favorecerá aún más la aposición de los fragmentos.

Uno de los requisitos indispensables para la pronta consolidación de una fractura es su exacta coaptación y firme aplicación de las superficies fracturadas; al mismo tiempo es necesario asegurar su buena irrigación y una inmovilización perfecta, para que el proceso natural del callo o cicatriz ósea pueda verificarse normalmente.

Los medios mécanicos: clavos, tornillos, etc., llenan seguramente todos

éstos requisitos, excepto el de una buena irrigación.

El clavo metálico y el tornillo, infinitamente superiores por su resistencia, provocan inevitablemente ostiomielitis en los tejidos ya de por sí osteoporóticos de los viejos.

Los metales inoxidables de que están hechos, vitalium, oro, etc., aseguran también la menor irritabilidad hacia el tejido óseo, pero, de cualquier manera, son cuerpos extraños que en infinidad de casos se deben extraer posteriormente, en una segunda intervención.

El clavo óseo que voy a describir, no es ya el bastoncillo tallado y modelado desprovisto de sus envolturas perióstica y endióstica, que el aparato modelador de Albee entrega después de pasado por el torno. Lo que yo propongo es un verdadero injerto con sus envolturas normales tomado de la tibia con la sierra eléctrica, vertiendo suero fisiológico frío en el momento de tallarlo con la sierra (para evitar la elevación de temperatura por fricción), obteniendo el injerto con la mayor cantidad de elementos vivos.

La forma del injerto no es cilíndrica sino triangular, como una alcayata con una punta suficientemente delgada, pero resistente, y una base más ancha que el diámetro del perforador, para que entre forzado en el tunel perforado y con ello aproxime más estrechamente las superficies de fractura. Este injerto lo tomo con las sierras paralelas suficientemente separadas para que me dé una base de dos centímetros; antes de separarlo, lo divido oblicuamente para obtener los dos clavos triangulares que voy a emplear.

Estos injertos llevan periostio adherido y fragmentos de médula que aseguran su vitalidad.

Como una sola de éstas clavijas sería débil, coloco dos; siguiendo las direcciones de las fajas de resistencia de cuello, en forma de ángulo agudo, coincidiendo en el centro de la cabeza con el objeto de que la clavija inferior ofrezca un fuerte apoyo a la superior, como si fuera una ménsula.

Los canalículos de Havers del hueso fresco acabado de tomar con la sierra, más los fragmentos de médula que lleva el injerto, aseguran el aporte de elementos vivos, que acarrearán osteoblastos y facilitarán la formació de una red de capilares que irrigarán la cabeza desprovista o empobrecida de circulación.

TECNICA

Colocación del enfermo sobre la mesa de Albee. Después de anestesiarlo, se fijan ambos pies a los estribos de tracción y se hace fuerte tracción de ambas piernas, hasta igualar su longitud. Se lleva el lado fracturado un poco en abducción y se rota hacía adentro 60 grados. El trocánter entonces hace un fuerte saliente lateral; se obtiene una direcccción horizontal de trocánter y cuello y las superficies quedan fuertemente adosadas. Se toma una radiografía de control.

Preparación amplia del campo operatorio y de la pierna del mismo lado, para la toma de los injertos. Con el objeto de no dar a la herida operatoria de la cadera una exposición demasiado larga, procedo primero a la toma de los injertos.

(*a*) Toma del injerto: Incisión en la cara antero-interna de la tibia para descubrirla en una longitud de veinte centímetros. Sin levantar el periostio, se traza con la sierras paralelas, apartadas unos dos centímetros, dos cortes paralelos de doce a quince centímetros, según la longitud que necesite el injerto.

Antes de verificar el corte transversal para tomar el injerto, se unen oblicuamente los extremos a fin de obtener

los dos clavos con la sierra única. Uniendo los trazos en sus extremos podemos obtener los dos clavos triangulares que son despuntados ligeramente para que no se fracturen en su extremidad.

(*b*) Incisión en la cadera, un poco hacia abajo y afuera de la espina ilíaca antero-superior, iniciándo el trazo de la incisión curva que pase a unos ocho centímetros por debajo del trocánter. Se separan los músculo tensor de la facia-lata y sartorio. Se diseca el colgajo y para poderlo abatir se corta parte del músculo tensor en el extremo inferior de la incisión. Así abordamos la cara interior del trocánter; con la legra separamos el tejido fibroso y las inserciones del basto externo. La posición que hemos dado al muslo, de fuerte rotación interna, nos puede servir de guía para el perforamiento de los túneles donde clavaremos los injertos. Separando por disección roma los tejidos anteriores de la articulación, podemos con el dedo índice de la mano izquierda, como guía, perforar de una vez el trocánter y el cuello.

(*c*) Perforación de los túneles: Teniendo a la vista la radiografía de control tomada después de la reducción, podemos elegir los lugares para perforar.

Se inicia primero con un perforador corto el lugar de los dos túneles.

Se cambia luego por el perforador largo graduado, confrontando en la radiografía el tamaño y longitud del túnel.

Se perfora el túnel superior obdicuamente hacia arriba y adentro, teniendo, como expresé anteriormente, el dedo índice como guía para la dirección de ésta perforación. Una vez profundizada la perforación, se desconecta el mango de la sierra y se toman nuevas radiografías de control. Si la dirección está correcta, se saca el perforador y se coloca el primer injerto, clavándolo como si fuera una alcayata.

Con la dirección más oblicua aún hacia arriba, hacia la punta del primer injerto que debe haber quedado en el centro de la cabeza femoral o cerca de la superficie cartilaginosa, se perfora el túnel inferior controlando igualmente con el índice de la mano izquierda. Si se juzga conveniente se puede tomar otra radiografía de control.

Se clava el segundo injerto; se recortan ambos, para que no sobresalgan demasiado y se procede a la sutura por planos de la herida.

En la misma posición se inmoviliza con aparato enyesado todo el miembro inferior y las articulaciones de las vértebras lumbares.

RESUMEN

El autor estudia los problemas que deben tenerse presentes en las fracturas de la extremidad superior del fémur en las personas ancianas, incluyendo en su discusión los siguientes factores: el ángulo entre el cuello y la diáfisis del fémur, el ángulo de torsión, el aporte sanguíneo, toda debilidad interna de la epífisis y la tracción muscular sobre los fragmentos óseos. El autor se pronuncia en favor de los injertos óseos de preferencia a las agujas metálicas. Se describe en éste artículo la formación de "clavos" triangulares óseos tomados de la tibia, detallándose la técnica apropiada con el auxilio de radiografías tomadas previamente.

RÉSUMÉ

Les fractures de l'extremité supérieure du fémur chez les gens âgés constituent toujours un problème thérapeutique.

Quelques faits anatomiques doivent être tenues en compte pour appliquer le propre traitement orthopédique:

1.—L'angulation du col du fémur en relation avec la diaphyse, normalement de 130 dégrés, qui peut produire une coxa-adducta, ou bien une coxa-valga, si l'angle est anormalement fixé. 2.—L'angle de torsion, entre l'essieu du col et la diaphyse. 3.—La pauvre irrigation sanguine du col. 4.—La structure osseuse intérieure de l'épiphyse affaiblie, chez les vieux. 5.—La déviation des fragments par l'action des muscles pelviens.

Tous ces circonstances, déterminent la position dans laquelle le fémur doit être placé sur la table d'Albee: abduction, rotation interne et traction, de tel façon que les angles normaux d'inclination et de torsion peuvent être reconstruits, et que la procédure chirurgicale puisse être correctement accomplie.

Dans la technique recommandée, l'auteur ne conseille pas l'emploi des greffes métalliques, mais osseuses, il emploie deux greffes tibiales avec leur périoste, suivant la méthode ci-dessous:

1.—Deux greffes, tibiales, triangulaires, et pointues legèrement dans une des extrémités.

2.—Incision des tissus mous à la hanche, pour atteindre le grand trochanter en avant et en dehors.

3.—Ayant les radiographies devant, les yeux, les points d'élection sur le trochanter, sont choisis et les deux trous sont perforés à la profondeur nécessaire d'accord avec la longeur du col montrée par la radiographie. Les deux trous sont faits successivement, le supérieur premièrement, et des radiographies de controle son prises pour suivre une direction correcte. Alors, les greffes sont martelées ainsi successivement.

4.—Les portions des greffes qui restent en dehors, sont coupées.

5.—L'immobilisation est faite moyennant un appereil plâtré.

FIFTH INTERNATIONAL ASSEMBLY
INTERNATIONAL COLLEGE OF SURGEONS
March 24–27, Inclusive
LIMA, PERU
Dr. Francisco Graña, General Chairman